# CHEMICAL & METALLURGICAL ENGINEERING

Volume 47 Established 1902 Number 1

JANUARY 1940



**Young Engineering and Young Engineers** ..... 1

**Fertilizer Practice at Curtis Bay** ..... *R. S. McBride* ..... 4

Davison Chemical Corp. furnishes an excellent example of the penetration of chemical engineering ideas into the fertilizer industry.

**Italian Autarchy Almost Achieved** ..... *Giacomo Fauser* ..... 10

As far as chemical industry is concerned, Italy is rapidly approaching the goal she has set for herself—economic self-sufficiency.

**British Industry at War** ..... *Paul I. Smith* ..... 12

Management of chemical industry in Great Britain must solve many new problems resulting from the new wartime regulations.

**Typical Dryer Calculations** ..... *O. A. Hougen* ..... 15

By example Professor Hougen shows how to tackle difficult problems relating to the drying of solids during the constant-rate period.

**Chemical Work Simplification** ..... *J. R. Bailey* ..... 18

Every chemical plant can increase its operating efficiency by simplifying its work. First, plant employees must be educated.

**Construction With Sulphur Cements** ..... *C. R. Payne & W. W. Duecker* 20

Types and methods of acidproof and corrosion-resistant construction are described in this second of two articles on sulphur cements.

**Avoiding Clogged Bin Hoppers** ..... *C. O. Sandstrom* ..... 22

A practical approach to the problem of preventing bridging and "hanging up" in bin hoppers. This follows previous articles on bin construction.

**Nomographs Solve Orifice Equations** ..... *H. S. Winnicki & Ralph Koch* 24

Charts for both liquids and gases are presented, so designed as to avoid the causes for confusion that were inherent in earlier charts.

**Chemical Engineering Report No. 1—Plant Lighting** ..... 25

Inaugurating *Chem. & Met.'s* new series of chemical engineering reports is this highly factual and detailed study of chemical plant lighting.

**Equipment News** ..... 33

**Removal of Hydrogen Sulphide** ..... *Pictured Flow Sheet* ..... 37

The Girbitol Process for purifying sour natural gas and removing hydrogen sulphide from refinery gas is described in picture and diagram.


## What's ahead

### *Chemical Engineering Economics*

**Second in our new series of "*Chem. & Met.* Reports to Chemical Engineering Executives" will deal with the chemical raw materials for the process industries. Here you will find an exhaustive study of the prices and availability of those important commodities that are both made and consumed in chemical plant operations. Thus will be presented in even more useful form the economic studies that will feature February's 17th Annual Review and Statistical Number. And all this comes to you in addition to the regular editorial content of *Chem. & Met.***


S. D. KIRKPATRICK, *Editor* — M. A. WILLIAMSON, *Publisher*

JAMES A. LEE, *Managing Editor* — HENRY M. BATTERS, *Market Editor*

THEODORE R. OLIVE, *Associate Editor* — MELVIN E. CLARK, *Assistant Editor*

*Editorial Representatives*

PAUL D. V. MANNING, 68 Post St., San Francisco, Calif.

R. S. McBRIDE, 712 Jackson Pl., Washington, D. C.

E. S. STATELER, 520 N. Michigan Ave., Chicago, Ill.

EARLE MAULDIN, 1105 Rhodes-Haverty Bldg., Atlanta, Ga.

**As chemical industry moves into a new year with plants operating at or near capacity, men, materials and machinery are prepared to set new records. Here, workers are shown cleaning a basket-type strainer on a pipeline at Monsanto Chemical Co.'s East St. Louis plant.**

*Underwood*


Published monthly, price 35 cents a copy. Subscription rates—United States, Canada, Mexico, Central and South American countries, $3.00 a year. All other countries, $5.00 a year or 30 shillings. Entered as second-class matter, September 3, 1936, at Post Office at Albany, N. Y., under the Act of March 3, 1879. Printed in U. S. A.


Copyright 1940 by McGraw-Hill Publishing Co., Inc. Member A.B.C. Member A.B.P.



McGRAW-HILL PUBLISHING COMPANY, INC.

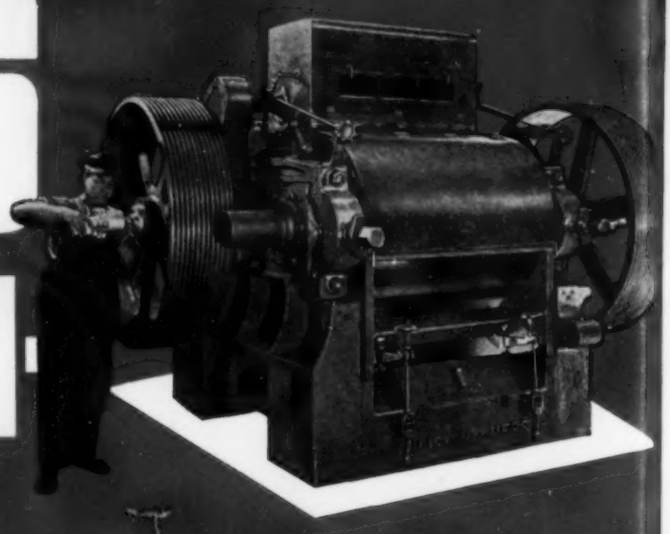
JAMES H. McGRAW, Founder and Honorary Chairman

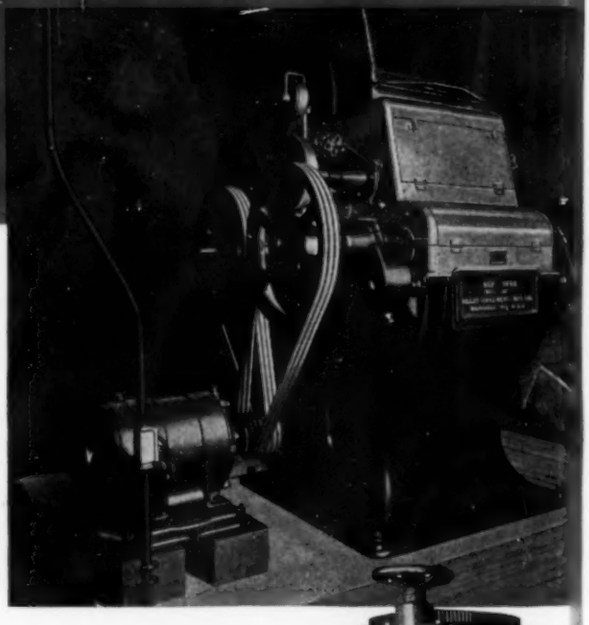
Publication office, 99-129 Broadway, Albany, N. Y. Editorial and executive offices, 330 West 42nd St., New York, N. Y. Cable address Mcgrawhill, N. Y. Branch offices: 520 North Michigan Ave., Chicago; San Francisco; Aldwych House, Aldwych, London, W.C. 2; Washington; Philadelphia; Cleveland; Detroit; St. Louis; Boston; Atlanta

JAMES H. McGRAW, JR., President — HOWARD EHRLICH, Exec. Vice-President — MASON BRITTON, Vice-Chairman — B. R. PUTNAM, Treasurer — D. C. McGRAW, Secretary — J. E. BLACKBURN, Director of Circulation

# WHAT'S YOUR PROBLEM-

## GRINDING... FLAKING... GRANULATING?





### Find the Money-Saving Answer to Processing Problems in Allis-Chalmers Modern Machinery! Make a Better Product at Less Cost!

Grinding . . . granulating . . . flaking . . . crushing . . . milling . . . crimping . . . cubing . . . shredding — these are the tough jobs in most processing plants. And it isn't easy to find equipment that will do them with modern efficiency . . . economically!

That's why you should know about Allis-Chalmers processing machinery. For whatever your problems, there is a special Allis-Chalmers machine to do the work for you . . . better! That's important.

But it's also important that you know about the field survey service that goes with Allis-Chalmers equipment . . . to help you get the right methods and machinery for your particular tasks . . . and to give you increased profits!

#### 90 Years of Experience Help You!

Remember — each Allis-Chalmers machine is designed, in its specialized field, to give you new, money-making efficiencies . . . new standards of performance. This has been the policy of Allis-Chalmers in over 90 years of making equipment for the processing industry.

Whether you want a complete survey of your plant . . . or merely bulletins describing new equipment — write Allis-Chalmers, Milwaukee. Or get in touch with the engineer in the district office near you.

A-1177

**THE LARGEST, MOST** efficient flaking machine (*upper*) ever built for the processing industry . . . has greater capacity, uses less power, has longer life. Many other sizes and types. Bulletin 1249A.

**ALLIS-CHALMERS** Roller Mills (*center*) —single, double, or in battery — are important factors in many processing plants . . . providing new, modern production standards. Send for Bulletin 1264.

**THE NEW, SENSATIONAL** Allis-Chalmers Interplane Grinder (*right*) mounts motor below mill frame, has exclusive top adjusting head . . . a flexible, money-saving processing development. Write for Bulletin 1267.

*Over 90 Years of Engineering Superiority Work for You When You Specify Allis-Chalmers!*

**ALLIS-CHALMERS**

MILWAUKEE · WISCONSIN

CHEMICAL & METALLURGICAL ENGINEERING
ESTABLISHED 1902

JANUARY, 1940

S. D. KIRKPATRICK, *Editor*

# Young Engineering and Young Engineers

HOPE, energy and enthusiasm are attributes of youth. Chemical industry is ever young. Chemical engineering is one of the most youthful branches of applied science. It has had its great growth and development in the decade that has just past. It faces an equally interesting and exciting future as its many practitioners push forward with their programs of research and development.

Now, as we move into this brand new decade of the '40s, is an appropriate time to give some thought to the problems we have been creating during our more or less reckless youth. We have generated a tremendous amount of enthusiasm which, if properly directed, can be most helpful—yet if misdirected, can give us an awful headache in the years to come.

Today, approximately 12,500 out of a total of 85,000 engineering students are studying chemical engineering. An annual crop of more than 2,000—perhaps even 2,500—graduate chemical engineers is an immediate prospect. How to absorb them into our industries and profession is no small problem. There are probably not more than 1,500 new jobs available each year in strictly chemical engineering work, i.e., in design, construction and operation of processes, plants and equipment in the chemical process industries. This means that a substantial proportion of our young engineers are going to have to find places for themselves in other than the older lines of technical work. They have got to carve out careers in sales and marketing, personnel, public relations and advertising—in short—in any capacity in which their chemical engineering training can be used to good advantage.

To some who would draw a rather narrow definition for the profession, this course might be regarded as involuntary desertion from the ranks. Yet isn't it exactly the sort of broadening of base that helped to put mechanical engineering into the dominant position it now holds in the engineering profession as a whole? Mechanical engineering grew strong in numbers and influence because its members were resourceful and flexible enough to adapt themselves to management and administrative responsibilities rather than to stick strictly to the engineering of machines and mechanics.

Fortunately, most of our chemical industries have already recognized the value of the services of fully trained chemical engineers in an ever widening variety of jobs. Our universities and colleges have been quick to sense the need for turning out men well grounded in fundamentals—educated not as incipient specialists, but trained to think for themselves. A few institutions are already combining chemical engineering with

courses in business administration. Many others provide incidental lectures that help to promote an appreciation of the meaning and importance of non-technical work in relation to the student's more specialized technology.

Our engineering societies, through student chapters and junior grades of membership have encouraged large numbers of young engineers to join in the organized work of the profession. Later on, many of these men hope and expect to qualify for either the associate or the active grades of membership. Some will be disappointed if the societies insist on narrow classifications that would limit membership to only those engineers engaged in purely technical pursuits. A broader view should and probably will prevail eventually.

### SELF-STARTING JUNIORS

TO DATE the most important achievement of the Engineers Council for Professional Development has undoubtedly been its contribution to engineering education in the United States. The work of accrediting curricula carried on by the large committees, formerly under the chairmanship of President Compton of M.I.T. and which are now headed by Dean Potter of Purdue, has been outstanding. It must be continued, for it is basic to the whole program of professional development. However, many feel that it is probably desirable this year to shift even more of the emphasis of E.C.P.D. to the Committee on Professional Training, which is the one that is concerned primarily with young engineers in the first four or five years out of college. The work of this committee, which started off so auspiciously a few years ago under the leadership of the late General Rees, is now being revitalized by his successor, Dean Eshbach of Northwestern. It has a big job to do, but fortunately one that already has a great impetus behind it.

Junior engineering groups, following the pattern developed a number of years ago by the Providence Engineering Society and including all branches of the engineering profession, are springing up in various parts of the country. Active associations restricted to younger chemical engineers in the New York, Philadelphia-Wilmington, Charleston, W. Va., and Niagara Falls areas, are setting a fast pace for their elders to follow. Other groups are in process of formation or actually under way. They provide an opportunity for self improvement and instruction through extension courses in nearby universities or through other adult educational agencies. More important, they open the way for personal and professional development through associations, group discussions, plant visits and other contacts with the people and things that are of interest to young engineers. Any help which any of us in the profession can lend to these junior engineering activities is distinctly worthwhile.

### OPPORTUNITIES

SOME young chemical engineers of our acquaintance have questioned whether it is worthwhile to take examinations for professional positions in the Federal Civil Service. As a consequence, a great many young men who might make excellent workers for the government and who might profit substantially from that sort of experience and special training are not available to the governmental departments that are prosecuting engineering and scientific research.

The organization of the four Regional Research Laboratories of the U. S. Department of Agriculture has spotlighted this problem. Those agencies are going to need a large number of additional chemical engineers during the next six to twelve months. These positions will range from those for beginners with the ink on their bachelor's diplomas scarcely dry, up to the more experienced men who can become leaders of research and development groups. Already a number of very capable men have been named. But not even all the senior posts have yet been filled. Few of the junior workers have yet been selected because the new laboratory buildings will not be ready until next summer or fall.

Some young men get into the government service and stay too long. Many others have served briefly with mutual profit to their employing bureaus and to the individuals themselves. Certain industries are, in fact, inclined to look over the government staffs and select the most promising young men there for larger responsibility in their own organizations. Sometimes young men of great promise in the government service are tempted away too soon by this technique. There is, however, a happy medium between staying too long and leaving prematurely.

The important point is that a young man who thinks that he might like to get the equivalent of graduate training in the government organization should make himself eligible by taking the appropriate examination. Those who look forward to that possibility, whether they expect $2,000 or $4,000 posts, can well place their names on record with the Civil Service Commission, Washington, D. C., requesting that they be notified of examinations when announced. The public service deserves to get some of the worth-while talent of our profession.

(More about other opportunities later!)

### MATTERS OF ETHICS

LAST YEAR, at the suggestion of President Ruthven of the University of Michigan, the students of the Engineering School at Ann Arbor started a series of seminars on professional ethics. Led by a number of the more experienced faculty members, these voluntary group meetings or parleys, as they were called, attracted a small but intensely interested audience that wrestled with actual case studies of ethical problems arising in the different fields of engineering. Impartial observers report that the ensuing discussions were extremely interesting and helpful to all concerned. Perhaps this is something that has possibilities for application entirely outside of educational institutions. Good ethics are not simply a matter of inherent belief or intuition as to what is right or wrong. They involve factual knowledge of actual practices and procedures, of principles that can be the basis for judgment and decision. We strongly suspect that the chemical engineering profession as a whole could be benefited by frequent and frank discussions of engineering ethics.

## OUR PLANS AND OBJECTIVES

CHEM. & MET.'S *raison d'etre* has recently been stated in these words:

> To present the chemical engineers' amazing accomplishments, explore their radiant hopes, examine their thorny problems.
>
> Production, the search for new products, the invention and application of new and better processes are among the most important things in the life of chemical engineers. And we try to be a thorough, candid investigator of their swiftly changing fields of operation.
>
> International affairs, government, the economics of national preparedness, the pressure of home and foreign markets now move in on the chemical engineer and his industries with relentless activity. *Chem. & Met.* is in the thick of it. For the measure of the impact of those forces on chemical engineering is the exact measure of their impact on *Chem. & Met.*
>
> Its editors seek to increase the over-all efficiency of production and management in the chemical process industries by examining NOW all the new elements of experience that become available, by studying NOW all the facts pertinent to their economy, so that unnecessary duplication of effort may be minimized, so that progress may be accelerated, so that helpful knowledge may be made widely available more speedily.
>
> Month-by-month, year-by-year, *Chem. & Met.* presents the hard-to-find facts about chemical engineering achievement and day-by-day progress for the benefit of chemical engineers wherever they may be.

Projecting that purpose into 1940, we plan a number of worthwhile innovations. First of all will be a series of *Chem. & Met. Reports*, presented as engineering studies that will be filled with useful data, containing the kind of information that chemical engineers need most to help them in their daily problems. They will be dated, indexed and classified and perhaps published later in reprint form so that readers may ultimately own a complete working library on such subjects as:

1. Plant Services—Lighting, Safety, Maintenance, Building Construction, etc.;
2. Unit Operations and Processes—Air Conditioning, Materials Handling, Power Transmission, Automatic Control and Instrumentation;
3. Chemical Engineering Economics—Raw Materials, Packaging, Marketing, Distribution Trends, etc.; and
4. Chemical Engineering Opportunities—The status of chemical engineering and of chemical engineers in a wide range of industries, the number and kinds of jobs available, the lines of promotion, responsibility, trends, unsolved problems, etc.

Series A, No. 1 of these reports appears in our current issue. As far as we know, it represents the first attempt to gather all the practical information and useful data necessary for a basic engineering study of the important function of adequate lighting of chemical plants. Next month's report, the first in the series on economics, will include an exhaustive study of chemical raw materials and the various factors affecting their availability. Therein will be presented in even more useful form, the data our readers have good reason to expect to find in a 17th Annual Review and Statistical Number.

Aware of the increasing interest in Southern developments and the necessity for supplementing an already intensive staff coverage, *Chem. & Met.* announces this month the appointment of a Southern Editor. Earle Mauldin, an experienced industrial engineer and editor, will have his offices in Atlanta, Ga., from which he will radiate in all directions of Southern chemical progress. May we speak for him your interest and cooperation in order that *Chem. & Met.* may better serve not only the South but all of chemical industry?

So much then by way of our own planning. What of yours? From our vantage point, 1940 looks like it is going to be a pretty good year. Production schedules were stepped up in the last quarter of 1939 so that they closely approximate the industry's all-time record established in the second quarter of 1937. Exports, which normally account for about 5 per cent of the total output, are steadily increasing, especially to South American and Oriental markets once dominated by Germany. Since practically all of the chemical consuming industries entered the new year on a relatively high plane of activity, and since foreign business seems certain to increase, it is our guess that the chemical industry for the first quarter of 1940 should operate at least 20 per cent above 1939's first quarter.

Most important of all is the opportunity for chemical engineers, young and old, to push back still further the horizons of the unknown and build for themselves that important place in the sun which the very first president of the American Institute of Chemical Engineers visualized 32 years ago in this stirring challenge:

> You who call yourselves chemical engineers, who know the science and the art, who feel your potency and your latent forces, you are to blame if you do not demand to be heard, to show by your efforts what stock you come from, and to demand of educators that in the future the title of the chemical engineer be clear, the training adequate and the public encouragement the strongest.

Sidney D. Kirkpatrick

---

**Volume 47—Chemical & Metallurgical Engineering—Number 1**

*Chemical & Metallurgical Engineering* is the successor to *Metallurgical & Chemical Engineering*, which in turn was a consolidation of *Electrochemical & Metallurgical Industry* and *Iron & Steel Magazine*, effected in July, 1906.

The magazine was originally founded as *Electrochemical Industry*, in September 1902, and was published monthly under the editorial direction of Dr. E. F. Roeber. It continued under that title until January, 1905, when it was changed to *Electrochemical & Metallurgical Industry*. In July, 1906, the consolidation was made with *Iron & Steel Magazine*, which had been founded eight years previously by Dr. Albert Sauveur. In January, 1910, the title was changed to *Metallurgical & Chemical Engineering*, and semi-monthly publication was begun Sept. 1, 1915. On July 1, 1918, the present title was assumed and weekly publication was begun Oct. 1, 1919. Monthly publication was resumed in March, 1925.

Dr. E. F. Roeber was editor of the paper from the time it was founded until his death on Oct. 17, 1917. After a brief interim he was succeeded by H. C. Parmelee. Ten years later, Nov. 1, 1928, Mr. Parmelee assumed other responsibilities in the McGraw-Hill Publishing Company and Sidney D. Kirkpatrick was appointed editor.

The editorial staff of the magazine comprises: James A. Lee, managing editor; H. M. Batters, market editor; T. R. Olive, associate editor, Melvin E. Clark, assistant editor. R. S. McBride, Paul D. V. Manning, E. S. Stateler and Earle Mauldin are editorial representatives in Washington, D. C., on the Pacific Coast, in Chicago, and in Atlanta, respectively. [All rights to above magazine titles are reserved by McGraw-Hill Publishing Co.]

# Fertilizer Practice at Curtis Bay

*How Davison Chemical Corp. has achieved a balanced fertilizer industry by applying modern chemical engineering concepts and economics is told here in the first of two articles. A second article, in an early issue, will discuss some of the company's recent advances in granulating, bagging and handling of superphosphate.*

R. S. McBRIDE
*Editorial Representative*
*Washington, D. C.*

FERTILIZER MAKING is becoming more and more a modern job of chemical engineering enterprise. It not only consumes the largest quantity of chemicals of any division of process industry, but also requires closer attention than ever before to good engineering and sound economic principles.

The fertilizer industry is dividing into two parts, one definitely chemical engineering in nature, the other primarily an industry marketing to agriculture. Both parts are of importance to chemical engineers; but, of course, the manufacturing division is the one of greatest technical significance. Davison Chemical Corp. covers both divisions of the industry; and it is one of the outstanding exponents of modern chemical engineering practice in the manufacturing portion of its activity. The planning and execution of this technical work, as well as its relationship to the marketing and agricultural problems, are interpreted here.

Practically all fertilizers used in the United States are prepared on a superphosphate base. This material is used alone in large tonnages and also almost invariably is the component present in largest quantities in mixed fertilizer. Since the manufacture of superphosphate consumes much sulphuric acid, the making of this important fertilizer material is often associated with the making of sulphuric acid. In fact, economic considerations are more and more making it necessary that the large scale superphosphate maker be also a sulphuric acid manufacturer. However, this acid maker usually must dispose of sulphuric acid as well for many things other than superphosphate, or he will be ignoring much of the opportunity for profitable acid manufacturing.

Perhaps none of the fertilizer companies has gone farther toward the modern concept of balanced industry than the Davison Chemical Corp. which has its principal plant on Curtis Bay, Baltimore, Md. A description of that plant affords an opportunity for interpreting the new trends which have real significance for many firms and many chemical engineers who do not think of themselves as concerned with either sulphuric acid or fertilizer questions.

### Acid Plant Operation

Successful manufacture of either acid or superphosphate is today necessarily a large-scale business. The small manufacturer of these commodities usually is at a great economic disadvantage. The capital required for materials handling and the skilled supervision for both superintendence and general management place disproportionately great burdens on any plant of small output. The Curtis Bay plant is illustrative of both large-scale efficient operation and the technique of balancing varied processes so that at all times an economic whole is achieved.

Sulphuric acid is made at the Davison plant by both the chamber and contact processes. Gradually the plant has been shifting over from all chamber units by installation of contact process equipment, partly to supplant and partly to supplement the

chamber capacity. At present there are two chamber acid units, one with 20 chambers and the other with 10.

The Davison plant has not adopted outside water cooling for its acid chambers. This practice is now followed by many other companies which secure thereby a greater capacity in pounds of acid made per day per cubic foot of chamber space. Under Baltimore conditions of this particular plant, however, the company feels that the cost of more lead for the wanted capacity is less than the cost for water-cooled chamber operation would be. Nitrogen oxides for catalysis are formed by ammonia oxidation (see *Chem. & Met.*, Oct., 1929, p. 614).

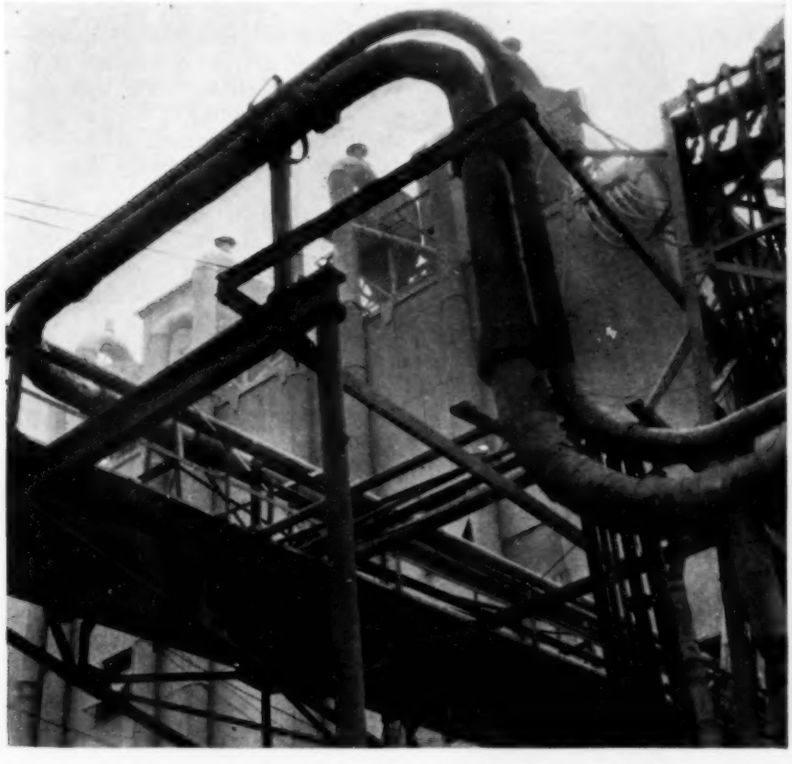
There are also two contact units, and a third one is now being installed. The catalyst used by Davison is platinum on silica gel. The present capacity is about two-thirds chamber and one-third contact acid, measured in tonnage. But when the new contact unit is complete, the relationship will be about 50–50.

Acid plant scheduling and operation of such varied acid equipment might seem to be a disadvantage, but actually it is not. The availability of several types of equipment permits ready control and a variation between 60 deg. Bé. and strong acid. The former is, of course, made by the chamber process for use in superphosphate manufacture. The latter is made primarily for sale. Adjustment between the two strengths and the two applications is one of the interesting chemical engineering achievements of this works.

Variation in output of each acid manufacturing unit is possible within fairly wide limits. Most efficient operating results, however, are obtainable at certain definite rates of operation well established by the experience of this company. Changes in acid requirement do occasion departures from this optimum for each plant, but the departures are much smaller and less frequent because of an interlocking of the two systems. This is the way the adjustment can be made.

Suppose that a surplus of low-strength fertilizer acid is available. It is not necessary to slow down the chambers. The surplus is simply pumped over to an arsenic-removal unit. When purified there, it is mixed with contact acid of above normal strength in order to prepare a marketable product of just the desired concentration, usually either 98 per cent or 66 deg. Bé. (93 per cent) acid. To permit this blending it is only necessary that the contact units be operated for the making of a super-strength product.

Since this variation can be made on the contact unit when it is operating at widely varying rates of output, there is practically complete control of the relative quantities of different strengths of acid made, without any substantial loss in efficiency.



Steam, electricity and moving air all work for the modern fertilizer maker

### Sulphur Supply

Not the least of the advantages of the deep-water location of the Davison plant is the availability of a variety of sulphur-bearing materials as well as sulphur. Under ordinary conditions this plant uses principally a Spanish pyrites brought in shipload lots direct from Spain to the unloading pier at Curtis Bay. Boats up to 26-ft. draft can be handled.

Many hundreds of years ago the Rio Tinto mines of Spain processed their ores with a discard of pyrites on to their dumps. Huge tonnages have lain there for 200 to 400 years. Only recently has the reclaiming of pyrites from these old tailings dumps been undertaken, but during recent years Davison has been able to take advantage of such supplies because of its favorable waterfront location and ability to take full ship loads at frequent intervals. The product so purchased has been the major sulphur supply of this company except when the recent Spanish war or other causes interrupted regular deliveries.

Under present circumstances the company is also using other sources of pyrites. Recently Canadian ore of slightly higher sulphur content, but definitely higher cost also, has been utilized in part. And, as a matter of good sense, substantial reserves in the stock pile have been built up by the company, so that any trouble with water haulage would not leave the plant without substantial reserves.

This plant also burns a limited amount of sulphur. One sulphur burner is used to fortify the $SO_2$ gas for the present chamber equipment. The new contact acid installation will include sulphur burners and it is expected that it will be operated exclusively on that raw material.

Not the least important of the chemical engineering adjustments of this plant is the facility with which more or less pyrites or sulphur can be used.

The docks at which incoming steamers discharge into this plant are

equipped with unloading gantry cranes. There are two of these units on the dock where pyrites is received. With clam shell buckets they can handle about 200 tons of material per hour out of typical ore steamers. The material is hoisted into dock hoppers from which it is dumped into a monorail conveyor and moved directly inshore from the pier to the pyrites storage bins. This storehouse building is located between the two acid plants so that a single stock serves conveniently for both and a single conveyor system can carry the material, again by monorail, from the stock piles into the pyrites burners which serve both the chamber and contact plants.

When greater stocks are required than can be stored in these capacious pyrites bins, the surplus is handled by truck. A truck-loading station is placed at the land end of the pier so that the monorail unloader after passing the scale house need move only a few feet to be over a truck-loading hopper. When the stock is to be piled elsewhere in the plant, as is needed when surplus reserves are being stored, the unloading of these goods is possible without requiring any extra handling beyond dumping from the pier conveyor into the dump trucks and the dumping of these at desired stockpile locations elsewhere in the plant.

When the pyrites is reclaimed from storage for use, a small automotive clam shell serves to pick it up from these reserve piles for return by truck to a point from which it is again hoisted by clam shell buckets into the pyrites storehouse. When one realizes the huge tonnage of such material that must be moved daily for a plant of this capacity, it is clear why the materials-handling problem is so important.

### Pyrites Burners

Each charge of pyrites from the stock pile is weighed as it goes to the charging hopper above a particular one of the 15 pyrites burners. Here the fine material, mostly under 8 mesh, is fed down through a coarse screen and spread by a rabble for drying on the roof of the Herreshoff furnace. The heat otherwise wasted by radiation from the top of the furnace is thus utilized to dry the mineral.

Combustion with controlled quantities of air takes place as the mineral travels downward from hearth to hearth through the eight sections of the furnace. The maximum gas temperature in the furnace is usually about 1,300 deg. F. By careful adjustment of dampers and rabble speed, the discharge of burned pyrites or cinder is maintained under close control. The sulphur content of the cinder is from 0.5 to 1.0 per cent S. It is possible to get sulphur lower than this, but not economic to do so.

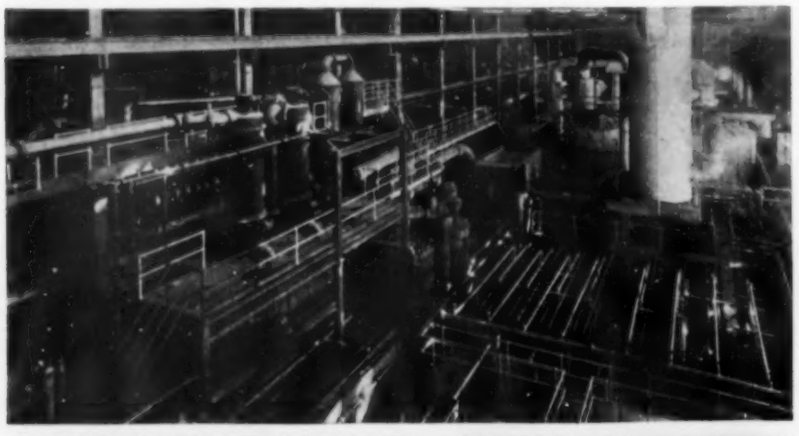
Each furnace burns approximately 28 tons of pyrites per day, maintaining about 8 per cent $SO_2$ in the discharge gas. When for any reason it is desired to fortify this gas to higher concentration for increased chamber capacity, a more concentrated gas is prepared in an auxiliary sulphur burner and fed into the mixture in the main collecting pipes.

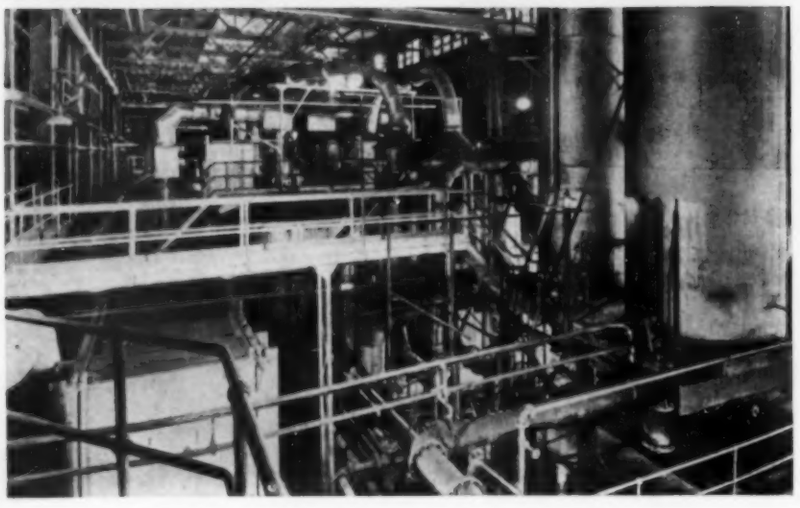
The $SO_2$ from the pyrites furnaces or sulphur burners is drawn through a dust collecting system. Three types of dust collectors are in use in this plant. Those most recently installed are Cottrell precipitators which function with substantially greater satisfaction to the management than either of the older types which are of the cyclone or shelf form. The amount of subsequent cleaning of the gas at the acid unit is determined by the effectiveness of these primary dust collectors.

As mentioned previously, the new contact acid plant now being installed will use only sulphur as raw material. It therefore will require a much lower capital investment since no dust-removal equipment will be necessary. It will have a waste-heat boiler installed between the sulphur burner and the acid equipment, giving for the first time in this plant direct by-product steam recovery. Most of the other older acid equipment is so largely "standard" or typical in nature as not to require description here.

Cleaning of pyrites burner gas for the contact process of acid manufacture is necessarily so complete as to remove all arsenic before the gas enters the convertors. Were this not done this impurity would poison the catalyst and render operation inefficient. The chamber-acid gas is not sufficiently cleaned to eliminate all arsenic. The acid made in that unit,

Views in Davison's contact sulphuric acid plant showing, above, acid coolers, absorbers and heat exchangers; and below, oleum and strong acid towers





therefore, contains a few parts per million of that element. This trace does no harm if the acid is to be used for superphosphate manufacture, but if some of the chamber acid is to be diverted to marketing, it is given a special arsenic treatment developed at Curtis Bay.

### Pyrites Byproduct

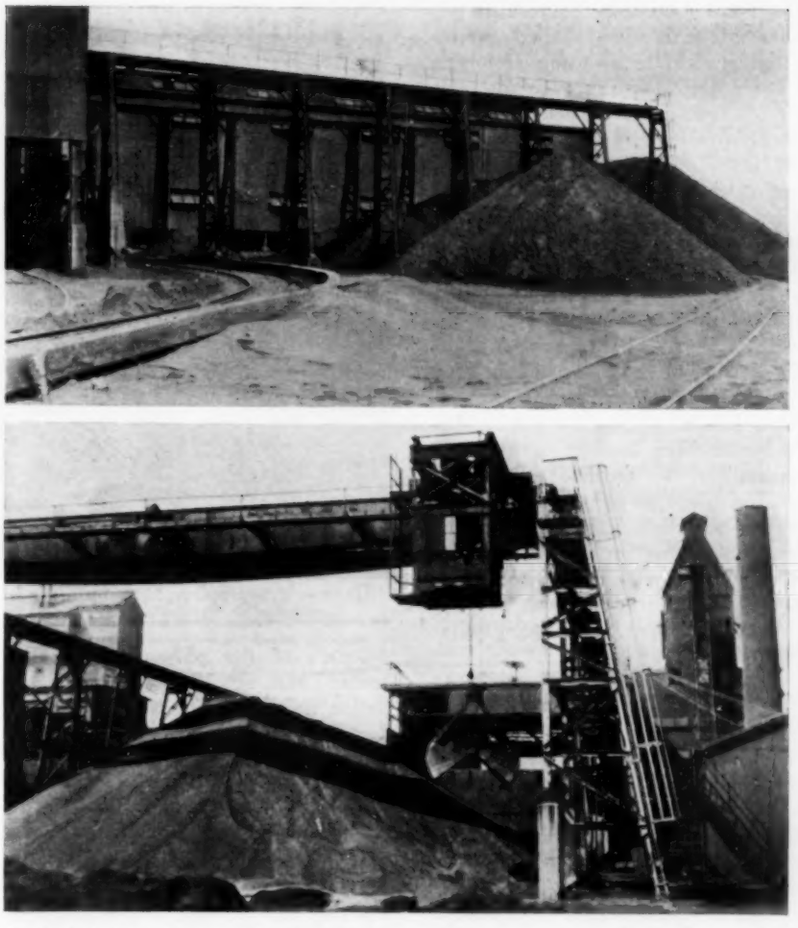
Many pyrites users find the spent cinder a relatively unprofitable byproduct if not actually a plant nuisance. At Curtis Bay this is not the case for a novel system of processing and sintering converts the cinder into an advantageous blast furnace raw material or "ore."

The cinder as it leaves the pyrites furnaces is fairly hot. It is collected in cubical boxes about 4 ft. on a side, one such cinder discharge unit being filled about once a shift at each furnace. These boxes are slid out from under the discharge side of the furnace and handled by crane out of the furnace room to a cinder dump nearby. There the cooling continues by outdoor exposure.

The spent cinder, although largely iron oxide, is unsuited for blast furnace use in two regards. It is much too fine for satisfactory furnace use and it contains copper in quantities objectionable to the iron maker. An unusual leaching and sintering technic has been developed by Davison engineers to remedy these two defects.

The cooled cinder is hoisted by clam shell bucket on a traveling crane from the cooling pile into leaching tanks of which there are eight, each about 20 by 30 ft., by 7 ft. deep. Here the crude material is leveled off and then subjected to a leach with weak sulphuric acid. This percolates down through the mass and out through the interstices of the wood-beamed bottom, taking in the acid substantially all of the readily soluble copper. After being sufficiently leached the material is washed with water, allowed to drain, hoisted out of the open tanks by crane, and thus transferred to the sintering department storage bins for final processing.

The leach acid is treated with scrap iron in a rotary copper precipitator. The copper sulphate in solution reacts with the scrap iron to form metallic copper and ferrous sulphate, the latter in solution. The copper, in elemental form or slightly oxidized, remains suspended in the solution and is removed by filtration. The filter cake after washing is dried in a large open dryer over an oil burner and the copper cement is ready for sale to a nearby copper company.



**Pyrites cinder, above, is leached and sintered to make a synthetic "iron ore," some of which appears, ready for shipment, in the view at the top**

### Cinder Sintering

The copper-free cinder is mixed with suitable quantities of fine bituminous coal and other materials, together with just enough moisture to permit proper pugging into a workable thick mud mass. The mixture includes both fines from previous sintering operations and dust that has been recovered from the hot stoves of a nearby blast furnace plant. The mud mixture is fed from the pug mill discharge down into a sintering machine. There, by combustion of the coal, the whole mass is aggregated in such a fashion that the resulting product is suitable for blast furnace charge.

The sintering machine is a series of traveling grates which form a continuous loop from the charging hopper to the discharge end and back underneath. Immediately after charging, the moving grate sections pass under igniting burners where an oil flame raises the mass to a temperature that will initiate combustion of the coal contained in the charge. Air for combustion is drawn down through the mass by a 600 horsepower fan which maintains a suction on the smoke duct, the latter being continuous under the entire length of the upper level of the sintering unit.

After the initial heating up by the oil burners, the combustion proceeds without further need for control as the grates travel the length of the machine. All of the coal is burned out and proper aggregation of the mass is accomplished by the time the grates turn over the discharge end and dump the hot sinter off through a hopper and chute into the sinter pit below. The grates return underneath, like a chain grate stoker.

It is most desirable if the sinter can be formed into pieces about the size of nut coal. Much of the sinter as it leaves the machine is larger than this, but it readily breaks up during its fall down through a large grizzly

screen and chute into the working pit. From this it is clam shelled out on to the stock pile awaiting shipment to the nearby blast furnace where it forms a much valued part of the ore charge. Incidentally the sulphur content is reduced during sintering to a point where this "synthetic ore" receives favorable reception from the furnace men.

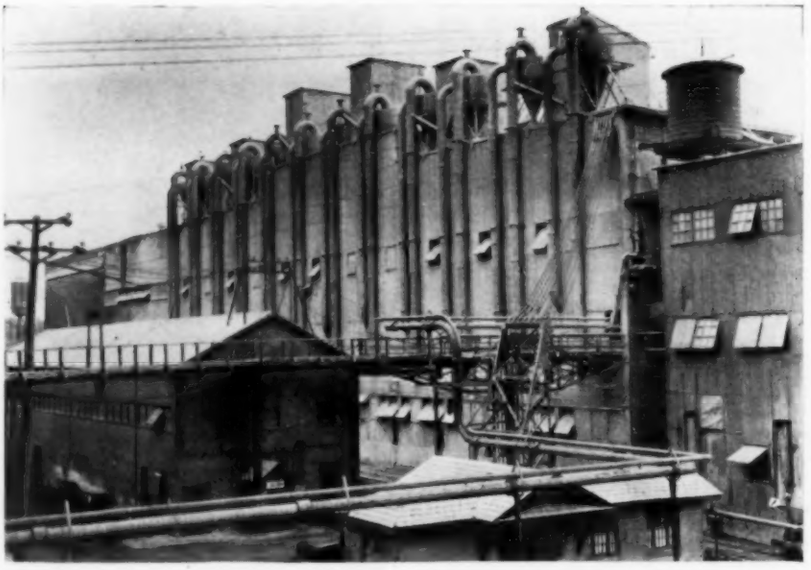
It is interesting to note that despite the large tonnage of material handled each month through the leaching and sintering department, the payroll of this division of the plant is kept low. A single crane serves for all materials handling from hot cinder discharge to final loading of cars for shipment of the finished sinter. The leaching plant is operated with one leacher per shift. The sintering unit has a small crew on each shift. Altogether, large-scale mechanized operation is necessary to make the by-products of copper and sinter profitable to the enterprise.

### Phosphate Rock

Steamers bringing the phosphate rock to this plant dock at a second pier directly opposite the superphosphate plant. Here again gantry cranes are installed for unloading from the steamships at about 400 tons per hour. The rock which is generally all through a 4-mesh screen is deposited by the pier cranes in dump cars which are moved inshore from the dock directly to the rock storage bins of the superphosphate building.

This company purchases its rock with attention to the other constituents, as well as to the B.P.L. (bone phosphate of lime). It is necessary in order to maintain about 20 per cent available $P_2O_5$ in the superphosphate that the rock used shall not be below about a 72 per cent B.P.L. grade.

From the rock stock pile the material is handled by crane into the feed hoppers of the phosphate grinding mills. There are 12 of these air separation units, each capable of providing about 4 tons per hour of fine rock powder, 87 per cent through 100 mesh and 62 per cent through 200. The mills are the ring-and-roll type with Raymond air separating cyclone units and dust system for collection of the fines. The dust collectors, which are on the roof of the superphosphate building, discharge into the ground rock storage hoppers just under the roof. From this point screw conveyors carry the fine rock to the superphosphate acidulators.



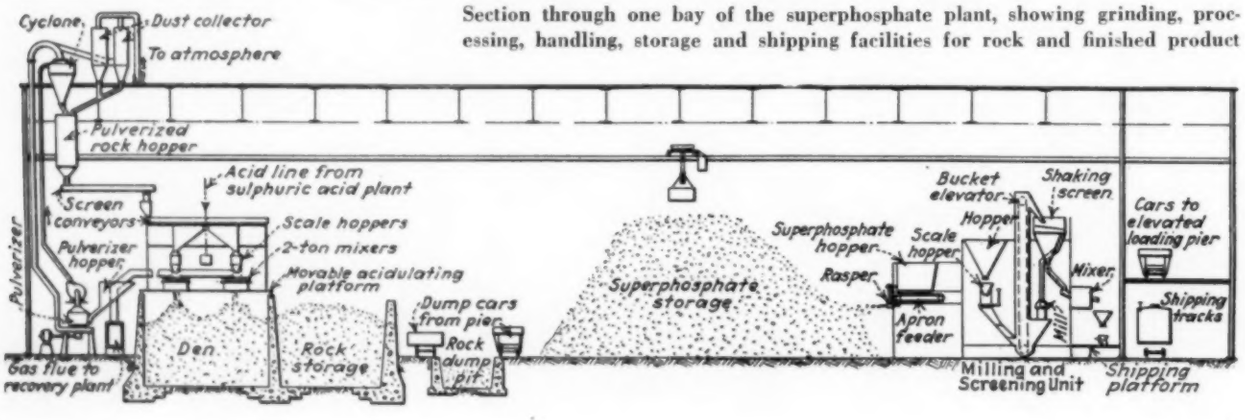
Davison's superphosphate building showing ground rock handling equipment

### Superphosphate Making

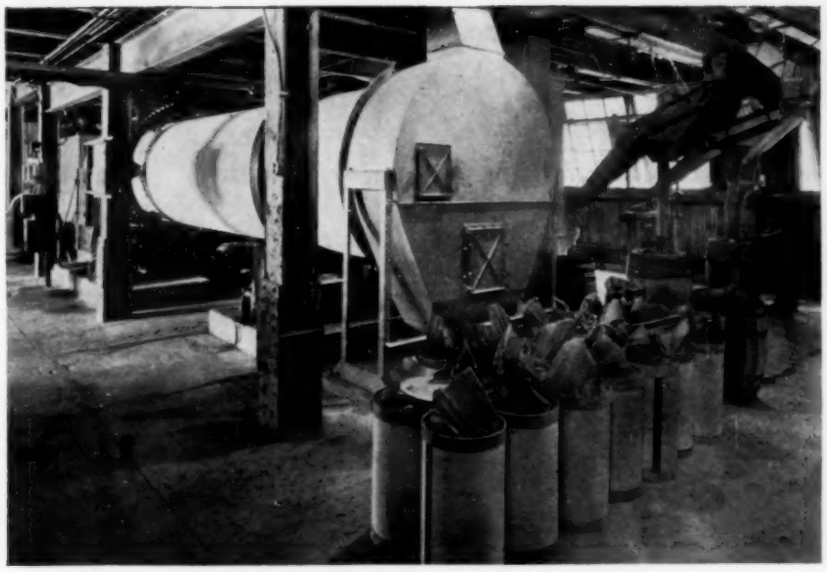
"Speed, and more speed" is the motto of this part of the plant. At present each mixer platform is so operated that two men, with a mixer each, can acidulate rock to form 100 tons of superphosphate per hour. This means that each mixer must be charged with about a half ton of rock and a half ton of acid 50 times per hour, a speed probably not achieved heretofore elsewhere. The result is, of course, a very favorable cost factor for both labor and capital investment in this part of the plant.

The quantity of acid and rock mixed is predetermined by the control laboratory. In calculating the mixed charge an unusual technique has been developed for accurate proportioning. This takes account not only of the phosphate content of the rock, but also of the other acid-using components. The result is a precise proportioning and exactly the desired surplus of acid in the mixture as it runs from the mixer to the den below.

In the mixer the tri-calcium phosphate reacts with the acid, heated to about 120 deg. F., and is converted to mono- and di-calcium phosphate with the formation of calcium sulphate and the liberation of the fluorine




Section through one bay of the superphosphate plant, showing grinding, processing, handling, storage and shipping facilities for rock and finished product



Drying and packing equipment in the fluorine byproducts department

from the complex fluoride-phosphate of the rock. The fluorine first forms hydrofluoric acid, but this immediately reacts with the silica or silicates present to form silicon tetrafluoride, which is drawn from the mixers through a duct and conveyed to a nearby building where fluorine compounds are manufactured—of which more later.

The mixture of rock and acid is a soupy mass that runs through a bottom discharge of the mixer to the den immediately below the mixer table. At full speed one table fills a den in about 4 hours. When one den is full, the mixing table is moved over the adjoining empty den. The mass remains in a den for several hours for completion of the acidulating reaction, but it is preferred that the material be all removed within 6 hours of filling. The removal is by an overhead crane with clam shell bucket which carries the material from the den to the nearby curing bins or to the granulators.

The crane when moving the fresh superphosphate does not dump this directly in the curing bins. To do so would form a pile of material of varying hardness, size of lump, and consistency. The old practice which did not have the present intermediate step suffered much subsequent difficulty in the handling of the cured super, and required a much longer time as well as considerable extra operation. The resulting superphosphate was also less uniform in character under the old process.

The intermediate processing used by Davison is known as rasping. The crude superphosphate is simply dumped into a large hopper from which it flows downward through a rapidly rotating star-knife arrangement. The blades of this rotating knife slice off or break up the chunks as they flow from the hopper and throw the resulting fine product through the air out to the stock pile. Thus all the material going into the stock pile is broken up, aerated well, and mixed again. Thereafter it cools, cures, and otherwise behaves itself very creditably and uniformly. Depending upon the speed of curing required, which varies with the activity of the plant and the demands for shipping, the material remains in the curing bins for varying lengths of time.

During the curing period the material is moved several times, if it is to be shipped as run-of-pile superphosphate. Formerly the routine was to move it five times, gradually advancing it from the position nearest the rasper to the opposite end of the storage bin, but the number and frequency of movements has been greatly reduced as a result of the rasper aeration. In fact, when phosphate is to remain in the warehouse for a considerable time before shipping, it is not necessary to move it at all.

In the Davison superphosphate building there is storage capacity for well over 100,000 tons of phosphatic material. This is a considerable quantity to have on hand at any one time, but it is necessary because fertilizer marketing is highly seasonal. Normally 60 per cent of the year's sales occur in a six-week period in the spring, with another smaller peak in the fall. The superphosphate manufacturer, on the other hand, must keep nearly a uniform production rate through the year if cost and price are to be low. Large storage is the inevitable result.

### Fluorine Byproducts

During reaction of the rock and acid, the double compound calcium fluoride-phosphate which occurs in the rock is broken up. The fluorine is given off as hydrofluoric acid which reacts with silicates and evolves silicon tetrafluoride. It is that compound which is drawn by the ventilating ducts out of the superphosphate mixers and dens to the fluorine byproduct building. There the material reacts with water to form hydrofluosilicic acid.

Davison Chemical is one of the few companies in the fertilizer business that recovers this material and makes chemical byproducts from it. At the Curtis Bay plant the magnesium, zinc, ammonium, copper, and sodium salts are prepared. The acid itself is also sold to some extent to be used as an electrolyte and as a disinfectant.

The principal use of the ammonium, sodium, and zinc silicofluorides is in the laundry industry as a "sour." Since soaps tend to be alkaline, these chemicals are used in the rinse water for the purpose of protecting the laundered fabrics from alkali damage during ironing or subsequent use. The ammonium salt is also used as a mothproofing agent. The sodium salt is applied in glass and enamel making, and to some extent as an insecticide.

Water solutions of the magnesium and zinc silicofluorides are used to harden and water-proof concrete surfaces and as a priming coat on newly plastered walls. Their use on concrete surfaces reduces dusting to a minimum and increases the hardness of the surface, thereby insuring greater wear. Public buildings, garages, power houses and machine shops are users of these materials. Magnesium silicofluoride is also used in the wood pulp industry.

The cordial cooperation of executives and plant staff of the Davison organization is gratefully acknowledged. Particularly the assistance of Mr. William H. Gabeler, general superintendent at Curtis Bay, has been most helpful in furnishing the excellent photographic illustrations, and in making possible this interpretation of the function of the chemical engineer in fertilizer making.

# Italian Autarchy Almost Achieved

***Spurred on by Il Duce's dream of industrial self-sufficiency, chemical industry in Italy continues its rapid technological advance.***


**GIACOMO FAUSER**
*Consulting Chemical Engineer*
*Novara, Italy*


OF ALL THE INDUSTRIES which go to make up the Italian national economy, chemical industry has progressed most in recent years. It will suffice to say that the index of production for the industry has increased about 25 per cent for the period January to June, 1939, over the same period last year. In view of this fact it seems proper for the author to bring up to date the information he supplied at that time. (See *Chem. & Met.* for March, 1938).

A brief outline of the actual progress in various parts of the industry will follow:

*Fuel*—For the past several months now, the huge plants of the National Agency for the Hydrogenation of Fuels at Bari and at Livorno have been producing regularly. This is one of the most important achievements of the self sufficiency program and is destined to become a great contribution to the prosperity of Italy and her colonial empire. This organization's production of oil is about 240,000 metric tons per year. From this total amount there are obtained 100,000 tons of high-octane fuels to be used for national aviation.

Oil from Albania constitutes the raw material and the quantity extracted is expected to reach 300,000 tons per year. In addition some oil is extracted from the bituminous schists which exist in important quantities in Abruzzi and Sicily.

In addition to these refineries which can nearly supply the entire national demand for oil, there are being erected units capable of producing 60,000 tons per year of lubricating oil.

*Fertilizers*—The Italian nitrogen industry has made considerable progress in the past two years. An ammonia plant of the Societa Vetrocoke à Mestre in Venice, can produce 100 tons per day, while the San Guiseppe plant at Savona, belonging to the Società Montecatini has increased its ammonia output to 200 tons per day. Here again Italy is in a position to supply her entire need for nitrogen, 126,000 metric tons in 1937.

In regard to phosphate fertilizers, the industry can supply 1,200,000 metric tons per year, an amount more than sufficient for Italian demands.

Definite work is being done to solve the potash problem. Leucite deposits, estimated at several hundred million tons, are being utilized as production on an industrial scale is about to be realized. This process will provide economical extraction of potassium and aluminum salts.

*Mining and Metallurgy*—Attempts to utilize completely pyrite cinders for the production of iron have been made, but traces of sulphur and copper must, of course, be removed carefully first. In 1938 more than 500,000 tons of pyrite cinders were supplied to the iron and steel industries.

Important lead and zinc deposits in Sardinia have been developed to supply Italian needs. The plant at Mestre regularly produces 12,000 tons of zinc per year by Professor Cambi's electrolytic process. Important quantities of cadmium are produced as a byproduct of this process.

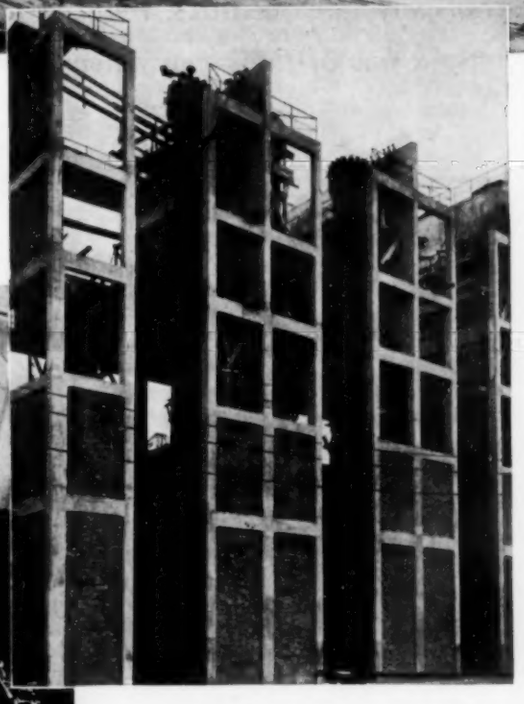
Similarly the Italian production of aluminum has increased annually to such an extent that this material acts as a substitute for copper in many of the principal electrical applications of the latter material. Bauxite previously came from Istria, but more recently deposits have been discovered in Puglie. These deposits are estimated at more than 2,000,000 metric tons. Italian aluminum plants have an actual capacity of about 40,000 tons annual production.

Among the technical achievements in this industry is the new 38,000 ampere furnace which has a continuous electrode manufactured in the new plants of the National Agency for Hydrogenation of Fuel.

Also under construction at the pres-

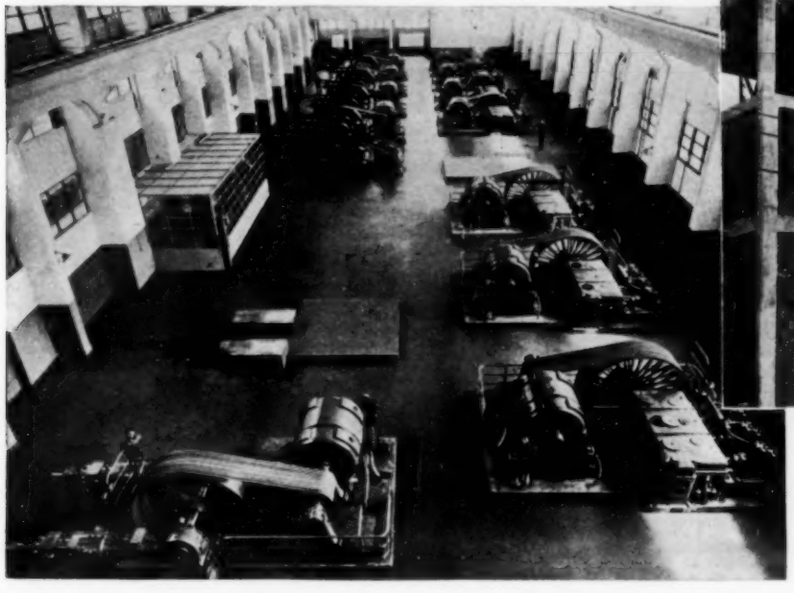
**Interior view at the Marghera plant for making aluminum. Recently discovered bauxite deposits are estimated at over two million tons**

Oil production of the National Agency for Hydrogenation of Fuels is about 240,000 tons annually. Above is a view of the Bari plant



Crude oil is obtained from Albania, hydrogenation is carried out in columns such as are shown at the right

Below:—Pump room of the N.A.H.F. plant at Livorno. Annual agency production of high-octane aviation fuels is 100,000 metric tons



ent time are three plants for the production of magnesium.

*Organic Chemicals*—Large new coke ovens have enabled Italy to put at the disposal of the chemical industry a remarkable quantity of byproducts necessary in the manufacture of dyes and pharmaceuticals. With these the Italians have been able to replace a good many imports.

A plant has been constructed for the production of a powerful new explosive $T_4$ (trimethylenetrinitramine), which is made from formaldehyde and ammonia. Also some plants produce pentrite, an explosive made from formaldehyde and acetaldehyde.

The first Italian plant for the production of synthetic rubber from ethyl alcohol is being built near Ferrara and will be finished within a few months.

To phenol-formaldehyde and urea-formaldehyde resins, already an established industry, have been added transparent acrylic resins and chlorovinyl resins. Other interesting products which have heretofore been imported are now about to be produced in Italy. Bromine extracted from sea water, tetraethyl lead, iodine, and potassium permanganate are a few of these. Also it is important to add that the Società Montecatini is building a plant at Novara to make nylon by the du Pont process.

*Cellulose*—Until recently practically all the cellulose has been imported into Italy. However, new projects will allow the country to furnish up to 50 per cent of its national requirements during the coming year.

We have learned since this article was written that these new projects are four new factories now under construction at Cuneo, Ferrara, Chieti and Capua. These plants will have an annual capacity of 88,000 tons of cellulose from chemically treated wood pulp (pine and chestnut). With them Italy expects to attain cellulose self-sufficiency by 1941, a year ahead of its present plan.—Editor.

The plant at Foggia, operating according to the Pomilio chlorination process, utilizes wheat straw as raw material, while the plant being built at Ferrara will use rice stalks.

As far as cellulose for rayon is concerned, the most important development is that of Snia Viscosa. This company manufactures cellulose starting from the Italian reed *Arundo-donax*. The production of rayon has attained great importance and more than 20,000,000 kilograms (22,000 short tons) is actually exported.

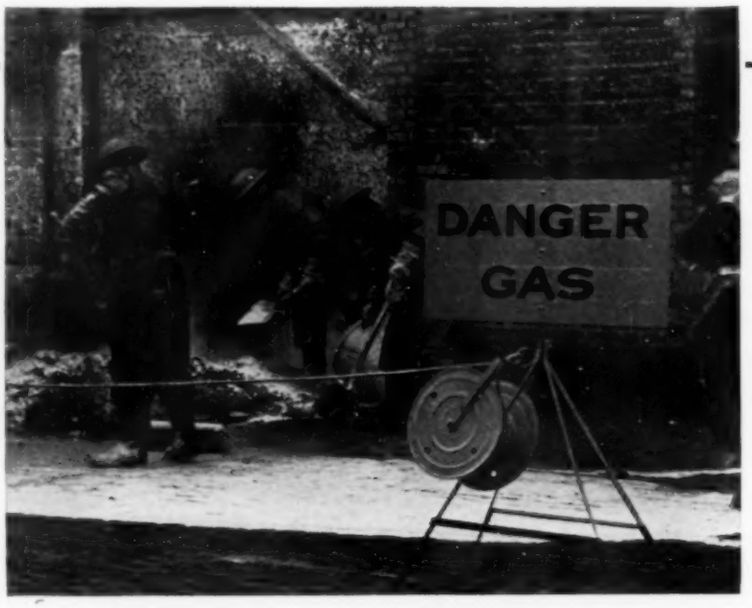
Likewise, the production of lanital, synthetic wool-like material made from casein, has progressed in Italy as well as abroad.

From this quick summary, one may conclude that the Italian chemical industry, despite grave difficulties which stand in the way of its development, has achieved a remarkable degree of self-sufficiency and it is in a position to take care of those exigencies most vital to the national economy.

# British Industry at War

*Activities of Britain's chemical manufacturers are governed by a whole new set of rules now that their country is at war. Air raid precautions, war risks insurance, curtailed transportation facilities, reduced man power and strict governmental regulations are only a few of their many new problems.*


**PAUL I. SMITH**
*Northwood Hills*
*Middlesex, England.*


**British chemical industry is well prepared to deal with all types of aerial offensive, including gas, incendiary bombs and high explosives. Demonstration squad of one chemical company is shown practicing**

THE GREAT WAR of 1914 or, as the French prefer to call it, "the other war" found the British chemical industry disorganized and ill prepared to make good the very serious deficiency in supplies and drugs, dyes, explosives, optical glass, etc., caused by the immediate cessation of supplies from Germany, which for years enjoyed an unchallenged supremacy in the world's chemical industry. Today, however, the position is vastly different and on the outbreak of war the leaders of Britain's well organized and extensive chemical industry were able to assure the Government that in practically every field of chemical manufacture the industry was either partially or completely self supporting.

### War Time Legislation

War time legislation of direct interest to the chemical industry has now reached voluminous proportions. Immediately on the outbreak of war the Minister of Supply, in pursuance of orders made under the Defense of the Realm Regulations, undertook the control of supplies and prices of a large number of chemicals, metals, textiles, fats, hides and skins, etc. In some cases supplies and prices were controlled and, in others, either supplies or prices. The most important order affecting the chemical industry was the one dealing with molasses and industrial alcohol and of substances which are normally produced from these, such as acetone, acetic acid, butyl alcohol, amyl acetate, etc. Manufacturers were asked to send in particulars of stocks of all these chemicals. The second order under the Regulations which has now come into force (September 29, 1939) not only fixes the prices of molasses and industrial alcohol together with chemicals produced from them, but restricts dealings to those granted licenses by the Minister of Supply. The Control of Mercury Order likewise regulates the consumption of mercury and the production of many of its important salts.

The Minister of Supply, acting with fifteen controllers of materials, has, either directly or indirectly, a virtual control of the chemical industry. The following materials now come under the direct control of the Minister—sulphuric acid; sulphate of ammonia; other fertilizers; alcohol and molasses; iron and steel; nonferrous metals (lead, zinc, tin and copper); aluminum; wool; flax; hemp; jute; silk and rayon; leather; timber and paper. The question of priority orders is one directly within the authority of the Minister of Supply who has, under the Priority of Work Order, 1939, the power of issuing priority orders which must receive preference over all other work.

### List of Reserved Occupations

Immediate publication of a list of reserved occupations, since amended, is generally recognized as a wise and timely move on the part of the Government, which is anxious not to repeat the appalling mistakes of the last war when skilled men, badly needed by the home industry, were fighting at the front. Reserved occupations include chemical and galenicals manufacture (including drugs); plastic and plastic goods manufacture; tar distillation, coke-oven byproducts; low temperature carbonization and hydrogenation plant; scientific workers, etc. Age limits are 25–35.

### War Risks Insurance

A war time measure which has had a very serious effect in the chemical industry is the War Risks (Commodity Insurance) (No. 2) Order, which makes it compulsory for manufacturers holding stock to the value of £1,000 and more to take out cover at the rate of one-half per cent per month for a period of three months from September 3, 1939. This insurance covers the risk of damage by king's enemies. Goods excepted for insurance include cement and cement clinker, lime, ores, concentrates, drosses and residues, scrap metal, copper, aluminum and lead, etc., but no chemicals. This levy of 6 per cent per annum has naturally caused a stiffening in the price of chemicals, but it does not justify some of the soaring prices during the last few weeks. Cresylic acid, 99 to 100 per cent, for instance, has moved up from about 1/10 to 2/10 the gallon for fair-sized parcels, while crude naphthalene, fire-lighter grade, is now realizing £5 a ton compared with £2.15 to £3 at the end of August. The board of Trade Index Number (1930 = 100) for industrial materials and manufactures for September 1939 was 107.4.

### Transport Facilities Curtailed

Transport facilities normally available to the chemical industry have been naturally curtailed by the present emergency. In the first place the Minister of Transport has requisitioned all privately-owned railway cars, except tank cars, cars specially set apart for specific traffics, such as cement, copperas, lime, etc.; registered cars reserved for internal use at collieries and works; specially constructed cars and those used on private railways. A certain number of motor trucks have also been commandeered by the War Office. The introduction of petrol rationing has not affected the chemical industry to the extent it might at first be thought, as a generous supplementary allowance is made for transport vehicles engaged in vital work. The rationing scheme has, however, been a source of both annoyance and inconvenience to the management on account of its crippling effect on the sales organizations.

### Air Raid Precautions

A.R.P., standing for Air Raid Precautions, will, it is said, be found written on every manufacturer's heart. Certainly to fulfill the requirements of the Civil Defense Act, 1939, has called for the expenditure of large sums of money and necessitated a great deal of careful planning on the part of overworked engineers and works managers.

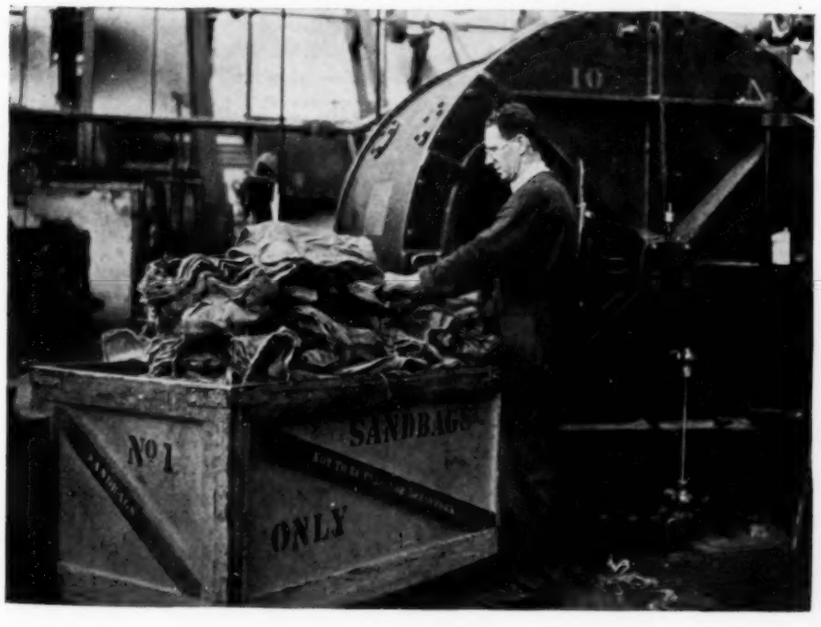
The Civil Defense Act, 1939, makes it obligatory for owners of factory premises in specified areas in which more than 50 persons are employed, to provide adequate air raid shelters for their work-people. Part III of the Act gives a list of these areas, which cover most of industrial Great Britain and certainly all the most important chemical plants in the country. Compulsory expenditure on A.R.P., which not only entails the provision of safe shelters, the obscuration of lighting, but the training and equipment of a suitable proportion of the employees in first aid, fire fighting and anti-gas measures, works out on the average at approximately £10 per head for every person employed. This figure does not include the expenditure on camouflage, a vitally important item in the case of large plants, and the cost of drilling Artesian wells to ensure an adequate supply of water for fire-fighting and processing in case the water mains are broken.

A certain amount of financial relief for compulsory expenditure on A.R.P. is given by the Government in the form of definite grants in the case of air raid shelters and camouflage and a reduction of income tax on trading profits for employers who have spent money on A.R.P. equipment and the obscuration of lights. Shelters must, in order to rank for grant, be of the approved standard and no sum is payable unless the work on the shelter was completed by September 30, 1939, or, alternately, in progress at that date.

Concealment of lights has presented a great problem to the chemical industry and one which has not yet been properly solved. The first measure taken in the war emergency was to paint all skylights and windows with a black matt paint, but this was soon found to present serious difficulties. In most cases ordinary factory lighting, which is designed only to supplement daylight except for the hour or so after dusk during the winter months, is quite inadequate to supplant daylight entirely. Attempts to increase general lighting in blacked-out buildings by merely substituting high for low wattage bulbs have not generally been very successful, because the ordinary lighting system is not designed to give that non-glare, uniform lighting so essential for efficient working. Some success has, however, been attained by painting all machines with aluminum paint and floodlighting the whitewashed walls of large buildings.

A recent method of tackling the lighting problem which is now being widely adopted is to provide movable black shutters for all windows and to

Load of sandbags ready for rot-proofing in a 15 per cent solution of copper naphthenate. Process involves a few minutes in a rotary treater



slide or hoist them into position half an hour after dusk, which is the official black-out time. Certainly this method is to be preferred to what might be called the scientific approach to the problem, which entails painting all windows a deep shade of blue and using orange tinted electric bulbs. In theory this method is excellent as, although no light is visible from the windows at night, the windows transmit a small amount of light, 4-7 per cent during the day. In practice, however, the ghostly blue light is very tiring to the eyes owing to its relatively high percentage of ultra-violet rays and, in consequence, many complaints are received by the Workers' Welfare Committees.

### New Plants and Products

The plastics industry, now exceedingly busy catering for abnormal demands for both thermo-plastic and thermo-setting resins owing to a shortage of non-ferrous metals and timber, is assured of ample supplies of raw materials once the chemical industry has passed through the present transitional period from peace to war. Tar distillers are able to keep the resin manufacturers fully supplied with phenol and in addition there is the emergency synthetic phenol plant held in reserve by the Monsanto Chemical Co. and now in operation. There is, however, a temporary shortage of formaldehyde produced from methyl alcohol by catalytic processes and some regrets are being expressed that the old wood distillation industry was not retained. Urea is plentiful owing to the assured supply of ammonia by the Imperial Chemical Industries and cellulose acetate production is being increased to new high records by Lancil Ltd., the main British producers.

A recent merger, which is likely to have important repercussions on the plastics industry, has been arranged between The Distillers Co., Ltd., and The British Xylonite Co., Ltd. The former company, with a paid up capital of £12,890,962, is one of the largest industrial undertakings in the country and, besides its distilling activities, produces Distrene, the all-British polystyrene resin. It has been agreed that The Distillers Co., Ltd., should acquire a half interest in BX Plastics Ltd., the plastics material manufacturing subsidiary of The British Xylonite Co., Ltd., capital £700,000. Incidentally, The British Xylonite Co., Ltd., is the only concern in the country with a synthetic camphor plant for the convenience of their large celluloid factory and this is now working 24 hours a day.

The British dyestuff industry, which has an output about eight times larger than it was in 1914, is fully able to satisfy home requirements and it is hoped that export trade to the Empire will be increased. The production figure for 1938, 45,502,043 lb. synthetic organic dyestuffs, was the lowest since the dark days of 1930, when the low level of 42,590,243 lb. was reached. The Control of Dyestuffs Order, 1939, is likely to be a powerful impetus to home production, as it prohibits the sale or supply of more than 1 lb. of a long list of dyestuffs or intermediates not wholly or partly made in Great Britain except by license from the Board of Trade.

Production of sulphuric acid is now being speeded up and many new plants are being put down. When figures are available for the whole year it will be seen that a considerable increase in production has been attained and it must be realized that there are a number of sulphuric acid plants in Great Britain held in reserve against just such an emergency as has now arisen. The third vanadium catalyst plant to be erected in Great Britain, at the works of F. W. Berk & Co., Ltd., is now in full operation. According to figures given at the time of the opening the plant has a rated capacity of 24 tons per day of 100 per cent sulphuric acid. It is impossible to give particulars of further new plants, but the Minister of Supply is making every effort to encourage manufacturers to extend their works. The same general remarks apply also to nitric acid and it was fortunate that in 1938 the Fertilizer & Synthetic Products Group of the I.C.I. completed at Billingham a nitric acid plant oxidizing ammonia under pressure.

It is natural to expect that the war will quicken both research and commercial exploitation of oil-from-coal processes. Effort is to be made by the Government to increase the 1938 figures: refined motor spirit from coal by low-temperature carbonization, 1.3 million gallons; 42.3 million gallons by hydrogenation and 54.7 million gallons at coke ovens, gas works and tar distilleries. A new process of considerable potential interest is that of Mr. D. Llewellyn Davies of Clydach, South Wales. It differs from low temperature carbonization and, according to experts, claims to give a good return with low-grade coals. The process claims that no catalyst is required; that 70 per cent of the weight of the coal reacted upon gives oil; the oil produced varies in C/H ratio from 8 to 10; and that the percentage of hydrogen content in coal reduces the cost of production. The new byproduct coking plant of the Ebbw Vale works of Richard Thomas & Co., Ltd., is now in full operation and comprises a fully equipped battery of 65 W-D Becker coke ovens, benzol recovery plant, etc. This installation, which was completed in the summer of 1939, is now making a valuable contribution to the nation's home-made fuel.

There is now a growing demand for certain specialized chemicals of interest to the paint industry, although the legitimate paint industry is almost dead. Copper naphthenate is required for rot-proofing sandbags, using a 15-20 per cent solution in white spirits and processing so as to leave the equivalent of 0.5 per cent metallic copper in the jute bags. Many thousands of untreated bags filled with earth and sand are now rotting outside important buildings in London and act as salutary object lessons to municipal and government authorities hesitating whether to pay the extra penny per bag for proofing. As a result of the black-out, luminous paints for exterior and interior uses are urgently called for and there is a need for strontium sulphide, the most important ingredient of most luminous paints. Fortunately there are considerable deposits of strontite in Argyllshire and at Padley Bridge in Yorkshire.

### Mobilizing Scientific Knowledge

There is no doubt that the War Department is fully cognizant of the value of scientists trained in chemical industry and it is now working in close collaboration with the Association of British Chemical Manufacturers, learned societies and the individual leaders of the industry. Commenting on the fact that Britain's war machine is now properly harnessed to scientific progress, the Director of Scientific Research in a statement to the press, November 8, 1939, said that in 1914 the War Department had fewer than 40 experts. By last September there were 800. In addition to this vast reserve of scientific knowledge, the Ministry of Supply included 27 teams of experts covering such varied subjects as organic and inorganic chemistry, physics, metallurgy, pharmacology, explosives and so on, with 27 key scientists and 112 assistants.

# Typical Dryer Calculations

*Typical calculations involved in the design and operation of drying equipment illustrate methods of attack on general problems in this important field. Part I of this article, presented here, considers two problems involving tray and drum drying during the constant-rate drying period; while Part II, to be presented in a future issue, will deal with calculations of the drying time and the optimum conditions of operation in various stages of drying in both compartment and progressive types of dryers.*

O. A. HOUGEN
*University of Wisconsin*
*Madison, Wis.*

DESPITE the great variety of dryers on the market and the unlimited variety of materials to be dried, the methods of calculating the drying time and the optimum conditions of drying can be reduced to a few general procedures. During recent years several advances have been made in the theory of drying and in the application of drying equations. In many cases experimental calculations are approached better from the standpoint of heat transmission than from vaporization coefficients. To illustrate these advances applications have been made to six specific problems in drying which are representative of a wide variety of materials and types of dryers.

The six types of problems discussed by the author include the following:

A. Drying during the constant-rate period.
   1. Solid in trays and uninsulated bottom
   2. Sheet material on a drum dryer

B. Drying during the falling-rate period of a sheet material
   1. Most economical air velocity at constant air temperatures.
   2. Optimum fraction of air to recirculate at constant air temperatures.
   3. Under adiabatic conditions.

C. Drying during all stages of a granular solid in trays with uninsulated bottoms from (a) top, (b) bottom, (c) top and bottom surfaces.

## Problem I—Drying during the Constant-Rate Period of Solids in Trays—Bottom Uninsulated

IT IS desired to calculate the time needed to dry a granular material 1 in. thick from 35 per cent to 10 per cent moisture content (dry basis) in a tray dryer. The stock is to be dried by blowing air horizontally over the top surface only, with the air at average condition of 140 deg. F., 10 per cent humidity and velocity of 1,960 ft. per min. The stock is placed in large galvanized iron trays with uninsulated bottoms exposed to the air stream, and is initially preheated to the temperature of the constant-rate period.

The critical moisture content of this material for top drying a layer 1 in. thick is 9.2 per cent (dry basis), hence the material dries at a constant rate over the entire range from 35 to 10 per cent. The density of the dry material is 86.5 lb. per cu. ft. It has been experimentally found that the rate of drying during the constant-rate period may be expressed by Equation (1).

$$R = \frac{dW}{Ad\theta} = 2.68\ V^{0.8}\ \Delta p \qquad (1)$$

$\Delta p = p_s - p_a$ in atm.
$V$ = air velocity in ft. per sec.

This problem is unique in that heat flows into the solid from two opposite sides, whereas evaporation takes place from the top surface only. Also, the solution introduces the generalized method proposed by Shepherd, Hadlock and Brewer (*Ind. Eng. Chem.*, pp. 388–397, 1938) for the constant-rate drying of non-hygroscopic solids.

*Solution*—When the tray is insulated on the bottom and side surfaces, the surface of the stock in drying attains the wet bulb temperature of the air during the constant-rate period. The temperatures and vapor pressures are as follows:

| | | | |
|---|---|---|---|
| dry bulb | 140 deg. F. | | |
| wet bulb | 87 deg. F. | vapor pressure | 0.0429 atm. |
| dew point | 69 deg. F. | vapor pressure | 0.0237 atm. |
| | | $\Delta p$ = | 0.0192 atm. |

$$R = (2.68)\left(\frac{1,960}{60}\right)^{0.8}(0.0192)$$

$$= 0.84 \text{ lb. per hr.-sq.ft.}$$

The total water evaporated per sq.ft. of surface

$$= \frac{86.5}{12}(0.35 - 0.10) = 1.80 \text{ lb.}$$

and the corresponding time of drying

$$\theta = \frac{1.80}{0.84} = 2.14 \text{ hr.}$$

The heat of vaporization including superheat is 1,068 B.t.u. per lb. at 87 deg. F. The corresponding heat transfer coefficient from air to wetted surface is, therefore,

$$\frac{(0.84)\ (1,068)}{140 - 87} = 16.9 \text{ B.t.u. per hr.-sq. ft.}$$

With an uninsulated tray, heat en-

Based on a paper titled "Drier Calculations and Design" presented before the Summer School for Chemical Engineering Teachers at Pennsylvania State College, June 27, 1939.

ters the bottom as well as the top surface. Since the air is moving at the same rate and temperature over the bottom surface, the heat transmission by convection at this surface is about the same as at the top. The thermal conductivity, $k$, of the wet sand is 2.0 B.t.u. per hr.-deg. F.-sq.ft.

With heat flowing into the bottom the temperature of the sand rises above the wet bulb temperature of the air. The total rate of heat flow at the surface of evaporation in B.t.u. per hr.-sq.ft. is

$$\frac{Q}{A\theta} = h_c (t_a - t_s) + \frac{t_a - t_s}{\frac{1}{h_c} + \frac{L}{k}} \quad (2)$$

where $h_c$ = H.T.C. by convection, B.t.u. per hr.-sq.ft. The same value of $h_c$ was used for both top and bottom surfaces.

Substituting in (2)

$$\frac{Q}{A\theta} = 16.9\,(140 - t_s) + \frac{140 - t_s}{\frac{1}{16.9} + \frac{1}{12(2)}}$$

B.t.u. per hr.-sq. ft. (3)

This neglects the gain of heat by radiation and the heat flow through the sides of pan, and assumes that the area of the metal heating surface is equal to that of the sand surface exposed to the air. The corresponding rate of evaporation is

$$R = 2.68\,(16.2)\,(p_s - 0.0237)$$

lb. per hr.-sq. ft. (4)

Multiplying Equation (4) by the latent heat of vaporization, 1,068, and equating to (3):

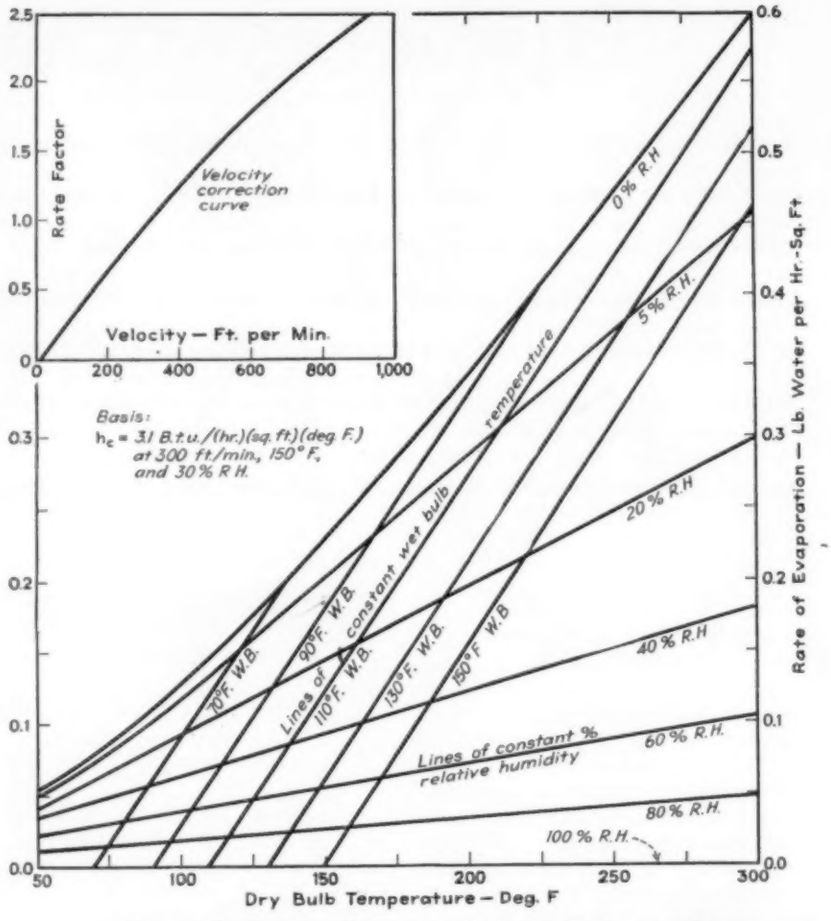
$$p_s = \frac{4{,}850 - 26.8\,t_s}{46{,}500} \text{ atm.} \quad (5)$$

From the vapor pressure chart of water when $t_s$ = 92.2 deg. F., $p_s$ = 0.0510 atm. These values satisfy Equation (5). The corresponding rate of evaporation is therefore

$R = (43.5)\,(0.0510 - 0.0237) = 1.19$ lb. per hr.-sq. ft., and the corrected time,

$$\theta = \frac{1.80}{1.19} = 1.51 \text{ hr.}$$

*Generalized Method for Constant-Rate Period*—Shepherd, Hadlock and Brewer (*loc. cit.*) have developed and recommended a generalized method of calculating the rate of evaporation, during the constant-rate period for drying in trays, of non-hygroscopic materials in a current of air. They also showed that more accurate experimental data could be obtained by calculating rates of drying from heat transmission coefficients than from mass transfer coefficients. A drying chart based upon experimental data on heat transmission coefficients through the wetted surface for convection only, after correcting for radiation, is shown herewith. This chart is recommended for the drying of all non-hygroscopic materials during the constant-rate period. The chart is based upon an air velocity of 300 feet per minute; for other velocities the value of $R$ obtained from the chart should be multiplied by $\left(\frac{V'}{300}\right)^{0.8}$ where $V'$ is in ft. per min.




**Rate of Evaporation Chart at a velocity of 300 ft. per min.**
(See Shepherd, Hadlock and Brewer, *Ind. Eng. Chem.*, pp. 388–397, 1938)

By use of the chart

$$R = (0.17)\left(\frac{1{,}960}{300}\right)^{0.8}$$

= 0.764 lb. per hr.-sq. ft.

The value of 0.84, obtained experimentally, is higher, due in part to the transfer of heat by radiation in the experiments. The corresponding value

$$h_c = \frac{(0.764)\,(1{,}068)}{53} = 15.4$$

When heat flows into the bottom of the tray the value obtained for wet bulb temperature drying should be multiplied by the factor,

$$\left[1 + \frac{1}{1 + \frac{h_c L}{k}}\right] \quad (6)$$

where the transfer of heat by radiation and the resistance of the pan are negligible, and where the unwetted area of tray is equal to the wetted area of the surface where evaporation is taking place.

The rate of evaporation from the uninsulated tray is, therefore,

$$R = (0.764)\left[1 + \frac{1}{1 + \frac{15.4}{(12)\,(2)}}\right]$$

= 1.23 lb. per hr.-sq. ft.

This latter value compares favorably with 1.19 lb. per sq.ft., by the previous method.

## Problem II. Drying During the Constant-Rate Period of a Sheet Material on an Internally Heated Drum Dryer

THE RATE of drying a sheet material on an internally heated steel drum is determined chiefly by the rate of heat transmission into the sheet from the drum. This problem is distinctly different from the preceding in that now the stock is at a higher temperature than that of the surrounding air, so that heat is being transferred to the air rather than from the air as in the usual case of air drying.

In the drying of a sheet material on a 4-ft. steel drum, steam is supplied to the drum at 200 deg. F., air is passed over the surface of the sheet at 100 deg. F., 40 per cent humidity at a velocity of 300 ft. per min. Calculate the

a. surface temperature of the sheet.
b. rate of heat flow in B.t.u. per hr.-sq.ft.
c. rate of evaporation in lb. per hr.-sq.ft.

For the removal of free moisture during the constant rate period the following equation holds:

$$R = 2.45\ V^{0.8}\ \Delta p \text{ lb. per hr.-sq. ft.}$$

where $p = (p_s - p_a)$ atm.

Resistance to the flow of heat is offered by the condensate formed on the inside of the drum, by the metal wall, by the sheet, and by the outside surface. Heat flows to the surface of the sheet through three resistances in series and into the air from the surface by three parallel paths, namely, radiation, convection and evaporation.

The rate of heat flow is hence given by the equation:

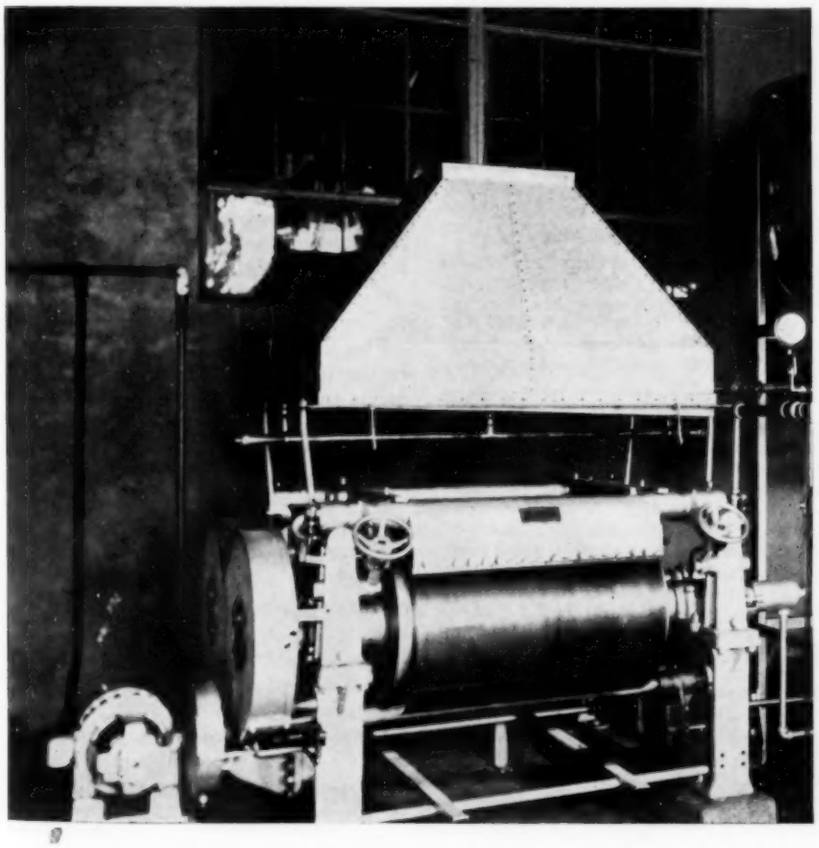
$$\frac{Q}{A\theta} = \frac{200 - 100}{\frac{1}{h_w} + \frac{1}{h_m} + \frac{1}{h_p} + \frac{1}{h_e + h_r + h_s}} \qquad (7)$$

where

$h_w$ = H.T.C. of condensate
= 800 B.t.u. per hr.-sq.ft.-deg.F.

$h_m$ = H.T.C. of metal
= 1,000 B.t.u. per hr.-sq.ft.-deg.F.

Rate of heat transmission into the sheet from the drum determines the rate of drying of a sheet material on internally-heated drum dryer



### Nomenclature

$A$ = area in sq.ft.
$\%h$ = percentage humidity of air.
$h$ = heat transmission coefficient, B.t.u. per hr.-sq.ft. deg. F.
$k$ = thermal conductivity, B.t.u. per hr.-deg F.-ft.
$L$ = thickness, ft.
$L$ = one-half thickness in feet when drying from two surfaces
$p$ = vapor pressure in atmospheres
$Q$ = heat, in B.t.u.
$R$ = rate of drying, lb. per hr.-sq.ft.
$t$ = temperature, deg. F.
$\Delta t$ = temperature drop, deg. F.
$V$ = air velocity in ft. per sec.
$V'$ = air velocity in ft. per min.
$W$ = weight of water in lb.
$\theta$ = time in hours
$\lambda$ = latent heat of vaporization, B.t.u. per lb.

#### Subscripts

$a$ = main stream of air
$c$ = by convection
$s$ = surface of evaporation
$f$ = film

$h_p$ = H.T.C. of sheet
= 800 B.t.u. per hr.-sq.ft.-deg.F.

$h_c$ = H.T.C. by convection
= 1.1 B.t.u. per hr.-sq.ft.-deg.F.

$h_r$ = H.T.C. by radiation
= 1.5 B.t.u. per hr.-sq.ft.-deg F.

$h_s$ = H.T.C. by evaporation

$$= \frac{2.45\ V^{0.8}\ \Delta p \lambda}{\Delta t_f}$$

Assume $t_s$ = 183 deg. F.
then $p_s$ = 0.547 atm.
$p_a$ = 0.033 atm.
$\Delta p$ = 0.514 atm.
$\lambda$ = 988 B.t.u. per lb.
$V$ = 5 ft. per sec.; $V^{0.8}$ = 3.62
$\Delta t_f$ = 83 deg. F.

$$h_s = \frac{(2.45)\ (3.62)\ (0.514)\ (988)}{83}$$

$$= 54.2$$

$$Q = \frac{200 - 100}{\frac{1}{800} + \frac{1}{1{,}000} + \frac{1}{800} + \frac{1}{1.1 + 1.5 + 54.2}}$$

$$= \frac{200 - 100}{0.0211} = 4{,}740 \text{ B.t.u. per hr.-sq.ft.}$$

$$\Delta t_f = \frac{0.0176}{0.0211} \times 100 = 83 \text{ deg. F.,}$$

and $t_s$ calculated = 183 deg. F.

Since the calculated value of $t_s$ agrees with the assumed value, the solution is correct, and

$$R = (2.45)\ (3.62)\ (0.514)$$
$$= 4.55 \text{ lb. per hr.-sq.ft.}$$

With air drying alone without supply of heat from the drum the value of $R$ would be only 0.65 lb. per hr.-sq.ft.

#### References


Ceaglske, N. H., and Hougen, O. A. Trans. A.I.Ch.E. 33, pp. 283-312 (1937).

Walker, Lewis, McAdams and Gilliland, "Principles of Chem. Engrg." McGraw-Hill Book Co. (1937).

# Chemical Work Simplification

***Competition is the ever-pressing stimulus toward greater economy in plant operation. To cut costs, many manufacturers are now considering and applying a program called "Work Simplification" which is designed to enlist the aid of all supervisory, technical and clerical employees in a search for new ideas.***


**J. R. BAILEY**

*Industrial Engineering Department*
*E. I. du Pont de Nemours & Co.*
*Wilmington, Del.*


WORK SIMPLIFICATION is a program constructed along scientific lines to train individuals to think creatively towards making a better product at a lower cost. It is designed for presentation to all members in the supervisory staff, various technical groups, and clerical groups in a plant.

One of the outgrowths of the 1931-1932 business depression was the start in industry toward training supervisory personnel to analyze operations for improvement. Before 1930-1931 industry tried to centralize the production of ideas. Companies employed men to plan and create ideas, and other men to carry out these plans. This method, while satisfactory to a limited extent, has been found inadequate for the needs of industry due to the necessity for continually lowering selling prices to meet competition. It lacks the creative participation of all those engaged in the operation of a given plant, and also tends to fall down in periods of plant expansion.

### Ask the Men Who Know

Since ideas are likely to originate where the need is most acute, they should come spontaneously from those people closely associated with the operation, and for that reason, these men should be given an education in work simplification.

Work simplification was originated by Mr. Allen H. Mogensen, Industrial Consultant, and has been adapted to chemical industry by the Industrial Engineering Department of du Pont. In conducting a program of this type, the feeling on the part of some supervisors and technical men that present conditions are satisfactory, must be eliminated. One of management's worries at the present time is the obsolescence of this class of personnel because they, like other people, tend to become closed-minded and resist new ideas.

### . . . On Open-Mindedness

General Motors Consumers Research Staff Booklet No. 38 has expressed this thought by drawing an analogy from the performance of processionary caterpillars. This booklet goes on to say:

"Processionary caterpillars feed upon pine needles; they move through the trees in a long procession, one leading and the others following—each with his eyes half closed and head snugly fitted against the rear extremity of his predecessor.

"Jean-Henri Fabre, the great French naturalist, after patiently experimenting with a group of these caterpillars, enticed them to the rim of a large flower pot where he succeeded in getting the first one connected up with the last one, thus forming a complete circle which started moving around in a procession which had neither beginning nor end.

"The naturalist expected that after a while they would catch on to the joke—get tired of their useless march and start off in some new direction, but not so.

"Through sheer force of habit the living, creeping circle kept moving around the rim of the pot, around and around, keeping the same relentless pace for seven days and seven nights—and would doubtless have continued longer, had it not been for sheer exhaustion and ultimate starvation.

"Incidentally, an ample supply of food was close at hand and plainly visible, but it was outside the range of the circle so they continued along the beaten path.

"They were following instinct—habit—custom—tradition—precedent—past experience—or whatever you may choose to call it, but they were following it blindly.

"They mistook activity for accomplishment, they meant well, but they got no place."

The work simplification program itself consists of sessions every other week which last an hour. These are given to groups of about 20 men. All types of process charts are discussed and analyzed. Photographs are taken of various operations showing present methods used in the plant. These are used for a discussion on "How quality can be improved and how the various items of controllable cost can be reduced." The fundamentals of motion economy are also discussed and certain operations that lend themselves to this procedure are analyzed for improvement.

### The Proper Attitude

The attitude which all of the men in the plant should have when looking at any job is, first, why should the job be done; and, second, if it is absolutely necessary that the job be done, why should we do it this way and what better methods are there for performing the job. The emphasis is never placed on labor cost reduction alone.

For example, let us analyze an ordinary plate and frame filter press. From a picture of this type of press, it is possible to ask such questions as "Why is the press necessary? What other ways are there of more economical filtering? What should be the temperature of the solution going into the press? What should be the rate

Based on a paper titled "Work Simplification in Chemical Industries" presented before the Providence meeting of the American Institute of Chemical Engineers, November 16, 1939.

of flow? What is the capacity of each plate and frame? Are there the correct number of plates and frames in the press? Can any better material be used for plates and frames? Is the most economical filter cloth used? Is it necessary to use filter aid? How often is the press cleaned? Why should it be cleaned at these intervals? What are the losses from leakage and what can be done to correct them? Lastly, what routine does the operator go through to clean the press?"

This method of attack can be used on any job in the plant whether it be operations, maintenance work, or clerical work.

### Can It Be Operated?

There is an application of work simplification which, in a good many chemical plants, is being overlooked. The chemical engineer is primarily concerned with the correct piece of equipment to be used to perform a certain job. The design engineer is concerned also with the proper equipment and where that equipment will be placed in the plant. Very little, if any, attention is paid to how the operator is going to operate that piece of equipment. In some cases it takes a contortionist or a man on roller skates to operate a given piece of equipment or a whole operation. This, of course, means that the cost of the product is higher at the start than it should be, and the plant will face the unpleasant and difficult task of eliminating labor which should never have been employed. This condition must be corrected if plants are going to start operation with the minimum amount of inconvenience and without having an excess labor force on hand.

### Answer Is Good Layout

This condition can be corrected if, in design and layout work, the engineer will either concern himself with the labor involved or ask assistance from those individuals who specialize in efficient layouts. The same questioning attitudes which are used for improvements in operations already in existence can be used in analyzing the design and layout of a process. It is a comparatively simple matter to change layouts on paper before the installation. It also requires a minimum of time to put down on paper the path of travel of the elements of work which the operator performs. The author has seen several cases where it was possible to combine operations by analyzing the layout merely by placing certain extension handles on valves, by the proper location of control panels, or by the installation of certain recording or indicating instruments. The time has come when design engineers must recognize the possibilities of work simplification for improving proposed equipment designs and plant layouts.

### Case Studies

Moving pictures of a number of case studies conducted in du Pont plants were shown at the Providence Meeting of A.I.Ch.E. In most cases these pictures indicate labor cost reduction as it is difficult to film improvements made in other controllable cost items. These improvements may seem trivial; however a close inspection of any process industry plant will disclose similar cost-consuming operations. Some of these are described in the following paragraphs.

*Lubrication of Overhead Shafting*—The old method of shutting down the equipment, then procuring a ladder in order to lubricate an overhead shaft shows a great amount of "make ready" and "put away" compared with the actual "do" part of the operation, which is lubricating. In the new method using central lubrication, most of this waste time has been eliminated.

*Weighing Lump Color Going From Dry Room to Grind Shop*—In the old method, the barrels of pigment were weighed when leaving the dry room going to the grind shop. The foreman asked, "Why is it necessary to weigh the pigment?" The answer showed that there was no justification for the expenditure of weighing. In any plant, there are many more operations which, if someone asked "Why?" could be eliminated entirely.

*Mechanic Getting Drill From Store Room*—A mechanic, operating a drill press in the Maintenance Department, walked 150 ft. to the store room to secure a drill and 150 ft. back to the drill press. After using the drill, he walked 150 ft. to the store room and 150 ft. back to his job. Unnecessary walking while performing any operation adds no value to the product and is one of the wastes which must be eliminated. The new method is to locate the drills near the drill press.

*Cutting Filter Cloths*—The old method of laying the cloth on the floor for cutting is a very natural way of doing the job. The store room man wondered how it could be done easier, simpler and faster. The result was the suggestion of a table to cut filter cloths. Aside from a labor saving, greater accuracy in cutting resulted in a considerable saving in material.

*Shutting Down Tank Agitator*—One of the large storage tank's 75 h.p. motors, driving an agitator, was running while the tank was full for seven or eight hours. A foreman, being conscious of the elimination of waste in all its forms, recommended shutting down the motor driving the agitator while the material in the tank was waiting to be pumped to the next operation. This, of course, brought to light the fact that there might be other places in the plant where electrical motors were being run unnecessarily.

*Recovery of Worn Filter Cloths on a Plate and Frame Press*—One of the major expenses in operating filter presses is the cost of the filter cloths. One foreman, in watching the filter press in operation, observed the discarding of used cloths. He first recommended saving the good half of the cloth when one-half was worn out, and finally recommended the placing of two old cloths together over one plate to extend cloth life still further.

*Recovery of Yield Loss in a Residue*—After the solution in a vessel had been pumped to the next operation, a certain residue was left in the vessel, which was being discarded. This residue still had some soluble material in it and a foreman thought it could be recovered. The improvement was leaching the residue for the soluble material, which resulted in an increase in yield.

### Stimulate Creative Thinking

The chemical industry has not in most cases tapped the available brains in the plant for their constructive ideas. If we are to reduce cost and improve quality we must make everyone in the plant feel that his ideas are necessary. A program of this type will definitely stimulate creative thinking and arouse interest in the fulfillment of industry's creed. This creed, expressed at the 1938 International Management Conference by Mr. Louis H. Brown, President of Johns-Manville, is in part "that we should consistently seek to provide better values at a lower cost so that more of our people can enjoy more of the world's goods." . . . "That we should strive to develop the efficiency of industry so as to determine a fair return for the investing public and provide the highest possible reward for the productivity of labor."

# Construction With Sulphur Cement

*In a previous article it was shown that the chemical resistance of sulphur cements may be predicted from laboratory test results. Here, as promised, the same authors discuss physical properties of these cements and construction methods of structures in which they are used because of their acidproof and corrosion resistant qualities.*

C. R. PAYNE
*and*
W. W. DUECKER

*Mellon Institute of Industrial Research*
*Pittsburgh, Pa.*

LABORATORY TEST RESULTS may be translated into predictions as to how sulphur-cement-jointed structures will resist various corrosive conditions. This was shown in our previous article (*Chem. & Met.*, Dec. 1939, p. 766 ff.). In discussing the various industrial installations in which sulphur cement is in service, however, no mention was made of the types of construction. Types and methods of construction are well standardized and are based on the physical properties of the cement.

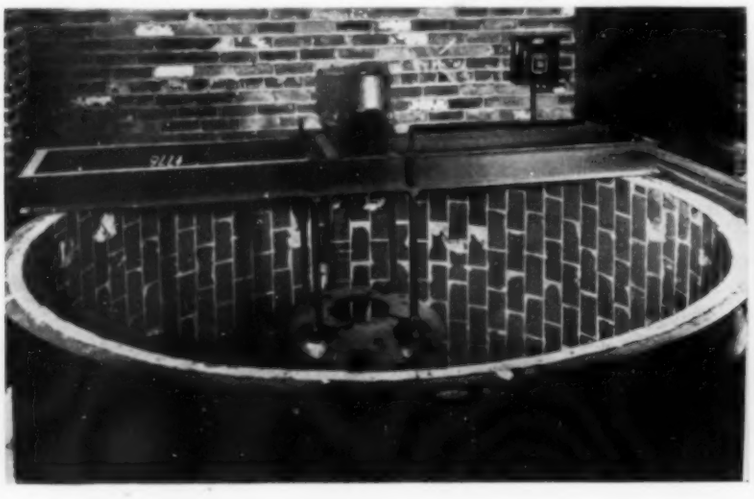
An important property of any acidproof cement that is to be used in the construction of chemical plant or other equipment is the absorption or porosity of the material. Acidproof ceramic materials are now available having an absorption of less than 1 per cent. One of the difficulties with ceramic linings has been recrystallization of salts within the pores of the jointing material, resulting in disintegration of the joint by the expansion of the crystals. A cement which is porous also has low resistance to abrasion and to the action of turbulent liquids. Sulphur cement has an absorption which closely approaches that of the best quality of vitrified products. For this reason sulphur cement has been used to special advantage in the lining of tanks and for the construction of acidproof floors where recrystallization of salts or abrasion is a factor.

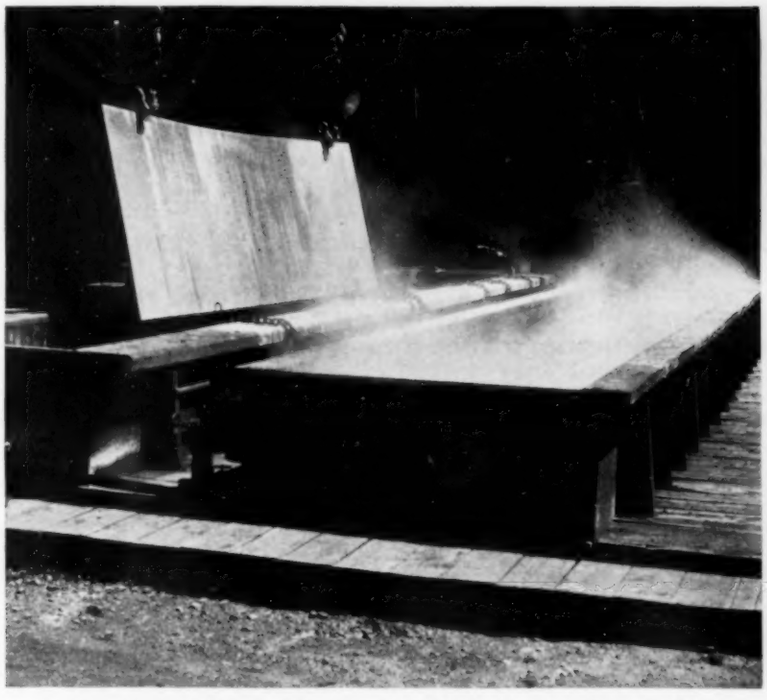
It should be noted that the coefficient of expansion of masonry jointed with sulphur cement compares favorably with that of reinforced concrete or steel. This property is of importance in the lining of concrete or steel tanks. Sulphur cements should not be subjected to temperatures above 93 deg. C. regardless of the solution. Above this temperature the coefficient of expansion is greatly increased and the life of the cement materially shortened.

Sulphur cement has good adhesion to all metals and is successfully used in contact with iron, lead, and acid-resisting alloys. However, for reasons discussed in the first article, it should

Based on a paper by the authors presented under the title "Chemical Resistance of Sulphur Cements" at the Providence meeting of the American Institute of Chemical Engineers, November 16, 1939. Dr. Payne is now with the Atlas Mineral Products Co. of Pennsylvania, Mertztown, Pa., and Dr. Duecker is with the Texas Gulf Sulphur Co., New York, N. Y.

**Below are two examples of construction with sulphur cement and acidproof brick. At the left is a process tank used for hydrochloric acid in a chemical plant and at the right is shown method of building an acidproof manhole**





Boiler plate pickling tank constructed of rubber lined steel; brick and sulphur cement protect rubber from heat and mechanical damage

Tank for pickling steel billets; wood on sides and bottom protects against abrasion

not be used in contact with copper. Determinations were made of the adhesion of sulphur cement to various types of acidproof brick. The best adhesion was obtained to a brick having a wire cut or scored bonding surface.

### Types of Construction

In general, tanks and similar equipment have reinforced concrete or steel as the outer supporting structure. In all instances such tanks must be liquid tight and sufficiently well designed to function as a rigid support for the brick lining.

Concrete tanks are lined with a plastic such as asphalt or alternate layers of asphalt and plastic sulphur cement and then lined with acidproof brick jointed with sulphur cement. A joint of sulphur cement is also cast between the brickwork and the plastic layer on the concrete, and this plastic layer is then sufficient protection against any possible seepage through the brick lining. The brick lining must be of sufficient thickness to furnish the necessary thermal protection to the plastic layer. The plastic layer should possess those physical properties which will permit the most economical brick lining and still have sufficient plasticity over the necessary temperature range to allow differential expansion between the brick lining and the concrete shell.

The most successful type of lining for steel tanks has been first to line the tank with rubber and then protect the rubber from oxidation, heat, and mechanical damage by a lining of acidproof brick jointed with sulphur cement. Practically all of the 300-ft. tanks for the continuous pickling of steel, which were previously described, are constructed in this manner. Rubber cannot be subjected to temperatures above 65 deg. C. and therefore varying thicknesses of brick linings are required, depending upon the operating temperature.

For the handling of hydrofluoric and nitric acid mixtures, the tanks are constructed of concrete or steel and this supporting shell is first protected with rubber, alternate layers of asphalt cement and plasticized sulphur, or similar materials. The plastic coating is then protected by a lining of carbon brick jointed with a carbon-base sulphur cement. Recently, a vinyl chloride coating has been developed which is highly resistant to both nitric and hydrofluoric acids. Steel tanks coated with this material and lined with carbon brick jointed with sulphur cement are giving excellent service. (Reference 13, first article, *loc. cit.*)

Expansion joints are usually constructed in brick linings which are over 30 ft. in length and subjected to elevated temperatures. The expansion joint is built up by cementing a series of horizontal and vertical soft unvulcanized rubber plates to their adjoining brick surfaces in such a manner as to displace a given volume which would otherwise be filled with sulphur cement. Upon the application of heat to the lining, the brickwork expands compressing the rubber into the pores of the brick and the rubber is vulcanized in that position. The rubber joint is woven or staggered throughout the brickwork in order not to sacrifice strength.

### Characteristics of Other Materials

| | Tensile Strength, Lb. per Sq. In. | Compressive Strength, Lb. per Sq. In. | Adhesion to Brick, Lb. per Sq. In. | Coefficient Expansion per Deg. F. | Absorption (A.S.T.M.) | Apparent Porosity (A.S.T.M.) |
|---|---|---|---|---|---|---|
| Sodium silicate (chemical set) | 335 | 2,730 | 185 | $6.2 \times 10^{-6}$ | 12.20 | 21.05 |
| Sodium silicate (evap. set) | 150 | 1,580 | 75 | | 15.26 | 23.46 |
| Portland cement mortar | 240 | 2,000 | 55 | | | |
| Acidproof brick‡ | 1,840-2,150§ | 7,000 | | | 1.5-3.2 | |

§ Modulus of rupture.

‡ Weight loss in 90 hours in conc. acids over steam bath: 0.24 per cent in $H_2SO_4$; 0.57 in $HNO_3$; 0.40 in HCl. In 10 per cent acids: 0.21 in $H_2SO_4$; 0.15 in $HNO_3$; 0.55 in HCl.

# Avoiding Clogged Bin Hoppers

*In a series of three articles in 1938 and early 1939, Mr. Sandstrom discussed and designed numerous bin constructions. In the present article he attacks an often overlooked problem, that of preventing bridging and "hanging-up" in bin hoppers.*

C. O. SANDSTROM
*Thermal Engineering Co.*
*Los Angeles, Calif.*

FEW THINGS are more exasperating than the clogged hopper of a bin serving a chemical process. Operations depending on the bin cease while sledges and pokeholes are manned to clear the hopper. Once clear and operations resumed, the designer of the bin comes in for a good cussing—"whynell didn't he make the hopper steeper?" being a favorite plaint.

Coarse material does not clog hoppers or spouts. Neither does dry fine material on the order of plus ¼-in. mesh. But finely ground material such as portland cement and pulverized coal will become compacted and stand in an almost vertical bank. Fine material slightly damp, either alone or mixed with coarser particles, will clog hoppers and spouts; and steep sides in the hopper is not a cure.

The tendency to clog is a function of the adhesive quality of the material, its natural internal friction, and the arching action caused by the sloping sides of the hopper. The adhesiveness of the material is lowered by drying, and the internal friction is lowered as the particles become smaller for much the same reason that the friction of any surface is lowered by smoothing. But little can be done about the slope of the hopper since there must be a reduction from the diameter of the bin, which is usually many feet, to the spout which may be a like number of inches. Increasing the slope of the hopper decreases its capacity, and for a given total capacity calls for a deeper bin, which in turn demands a higher elevator with a higher construction cost and greater power consumption.

In Fig. 1, *a* and *b* are sketches of two bins of equal capacity, one with a 45 deg. and the other with a 60 deg. hopper, which were considered for a certain boiler room that required ten bins. It was necessary to build a monitor in the roof to accommodate the conveyor, and as the monitor would be about 180 ft. long, one side being the extended brick wall of the building, it was not deemed worthwhile to assume the cost of the added 3 ft. of construction for the questionable advantage of steep hoppers in the bins, so bins of the kind shown at *a* were installed.

The daily trip of inspection took me along the conveyor a few feet above the tops of the bins, from where the insides of the bins were plainly visible. The behavior of the coal as it moved down from the condition of a surcharged, to empty, bin, was rather interesting. Sizes of coal from slack to mine-run that had been crushed to 1½-in. ring were used, depending on availability. Moisture content varied between wide limits, but clogging of the hopper outlets was a rare occurrence, and only with damp fine coal.

This plant burned about 200 tons of coal a dav. Since there were ten bins, the coal levels were at varying heights, displaying a kind of moving picture of the passage through the bins. Being mildly interested in the action, I arranged to have bins completely emptied when the boilers they served were cut out for cleaning. I have since regretted that measurements were not taken and a graphic record made of the action; but the time taken could not be justified on the score of improved or increased output, so nothing but a visual study was made. In other words, pure research, however soul-filling it might have been to an individual, would have been regarded as distinctly foreign to the purpose of the plant.

Starting off with a surcharge there was a general subsidence for about 2 ft. Then for another 2 ft. there was a levelling of the surcharge, which indicated a piping, or funnelling down the center of the mass of coal. In the next foot the surface became dished, the dish becoming a crater by the time the rim of coal was at mid-height of the wall of the bin. From there on the crater was an envelope of a cone, an element of which was inclined at an angle considerably greater than the angle at which the coal would slide down a flat plate; which greater angle was obviously due to the circumferential restraint. Shortly before the discharge opening was exposed, the coal began to flow down the surface of the envelope, which continued until a break in the surface occurred, exposing the steel hopper. This relieved the circumferential restraint, and the coal began to slide down the hopper, continuing until the hopper was empty.

### Eccentric Hoppers

Probably everyone who has watched the flow of material through a hoppered bin has thought that flow would be improved in an eccentric hopper; that is, a hopper whose discharge opening is off-center, to produce slopes varying up to the vertical. Fig. 1 *c*, *d* and *e* show three such hoppers, all of which have been reported as improved in self-cleaning ability. Of the three the one at *c* should prove the most satisfactory since the mini-

mum angle is 45 deg., whereas the edges of the dihedral angles of *d* and *e* are 42 deg. and 35 deg. respectively. To make the edges of the dihedral angles of *d* and *e* a minimum of 45 deg., the depths of these hoppers would have to be 12.5 and 41.7 per cent greater. The freer flow from hoppers *c*, *d* and *e* seems to be due to inability of the material to spring an arch from the smooth, vertical surface of the wall.

If one or two vertical sides in a hopper promotes the flow of material, it would seem that the arrangement of Fig. 1 *f* would prove effective. The central tube is the equivalent of a side and, being itself a hopper, does not reduce capacity.

### Mechanical Devices

Many mechanical devices have been tried to induce flow from hoppers. In certain fine materials compressed air is effective. This may be admitted continuously by means of a needle valve, or intermittently by linking the valve to the feeder mechanism. Should the material be affected by the small amount of moisture normally present in compressed air, the air should be dried before being sent to the hopper.

In Fig. 2 *a* is a method that is occasionally proposed, and which has probably been actually tried. A loop of chain is suspended from a sprocket that is keyed to a shaft passing through the sides of the hopper. As the sprocket turns, the downward moving strand of the chain is expected to drop through the material with the same speed as the upward moving strand. A moment's reflection should convince one that the scheme will not work. The downward moving strand of the chain must move with the same speed as the upward moving strand or the chain will come off the sprocket. A material that would permit this would be nearly fluid and hence would not clog the hopper. Even in very fine material like portland cement it would take a very heavy object to pass down through it. I have in mind a 7-in. cold chisel that was dropped into a bagging bin by accident. Two days later the bagging bin was started up, and six hours later the chisel was recovered at the outlet; having moved downward, not through the cement, but with it.

In Fig. 2 *b* and *c* are revolving stirrers, one vertical and the other horizontal. At *d* a rotary vane feeder is installed in the hopper and performs the dual function of stirrer and feeder. At *e* a grid is attached to the trunions of the gate, and every swing of the gate moves the grid through the same arc. Of course, this device can be used only in fine material, for if a large piece were squarely met by one of the bars of the grid, much force would be required to move it through the mass, and some part of the grid might be broken unless made extremely heavy. At *f* is an auxiliary hopper which is also a feeder. This hopper rocks on gudgeons in the lower end of the main, or stationary, hopper. The movement of the hopper forces a quantity of the material into the trough, the forward movement pushing it into the chute or spout. As is readily seen, the rocking motion prevents clogging by forcing the material down through the rocking hopper and into the spout.

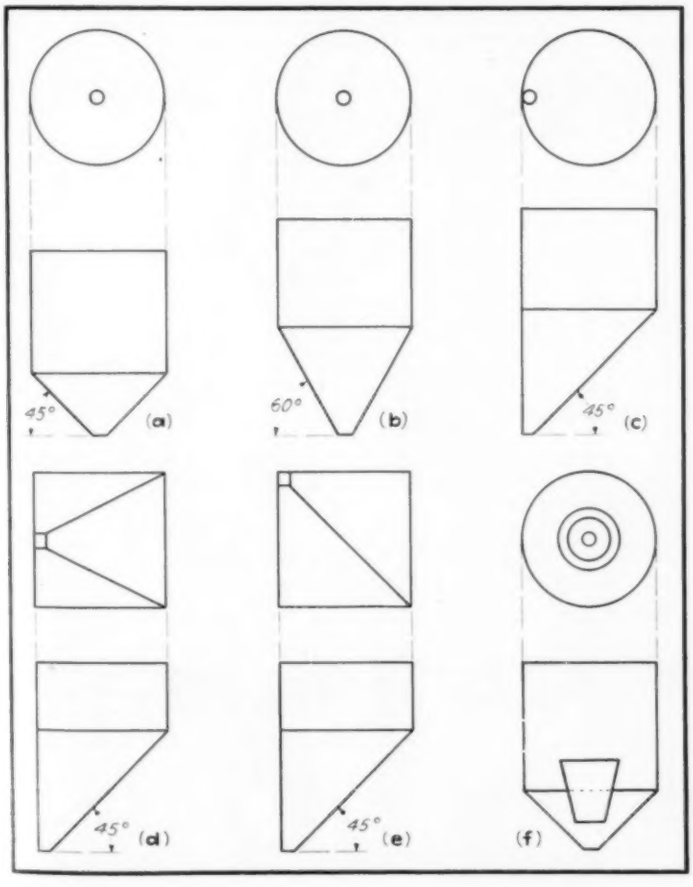
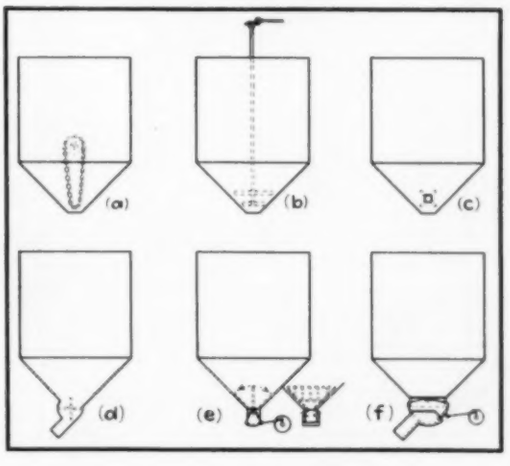



**Fig. 1, Left — Different designs for storage bin hoppers: *a* and *b* are two bins of equal capacity showing additional headroom required for steeper hopper angle; *c*, *d*, and *e* have off-center discharge openings which are reported as improved in self-cleaning ability; in *f*, the nearly vertical walls of the small inner hopper should prove effective**

**Fig. 2, Below — Mechanical devices which have been used or proposed to induce flow from hoppers: *a*, a favorite idea which doesn't work; *b* and *c*, revolving stirrers; *d*, a stirrer and feeder; *e*, a grid, used only on fine materials; *f*, an auxiliary hopper feeder**



# Your Plant NOTEBOOK

## CHARTS SOLVE ORIFICE EQUATIONS

By HENRY S. WINNICKI *and* RALPH KOCH

*Clarkson College of Technology*
*Potsdam, N. Y.*

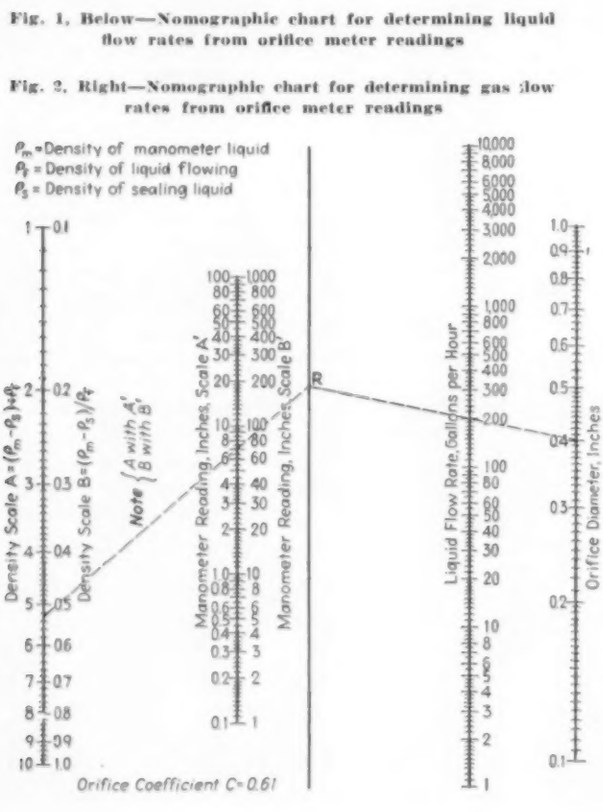
ALIGNMENT CHARTS for the solution of orifice equations for both gas and liquid flow have previously been published in *Chem. & Met.* (J. E. Pierce, Sept. 1936, p. 498). However, although these were entirely correct if properly interpreted, they were subject to improper use owing to the ambiguous labeling of the axes for differential pressures. If these axes had been clearly designated as in units of equivalent pressure drop across the orifice in inches of water, no trouble would have been experienced in their use, except that confusion might arise in attempting to convert the manometer reading to inches of water. To avoid this and other possibilities of confusion new charts have been prepared, based on the nomenclature and correction methods given on p. 1670 of Perry's "Chemical Engineers Handbook." Through the use of the expression $(\rho_m - \rho_s)/\rho_f$ (where $\rho_m$, $\rho_s$ and $\rho_f$ are the specific gravities respectively of the manometer, sealing and flowing liquids) a correction factor for the differential shown by the manometer is determined. Where no seal liquid is used, $\rho_f$ is substituted for $\rho_s$ in the above expression. When the fluid measured is a gas, $\rho_g$ is substituted for $\rho_f$, where $\rho_g$ is the specific gravity of the gas relative to air as 1.

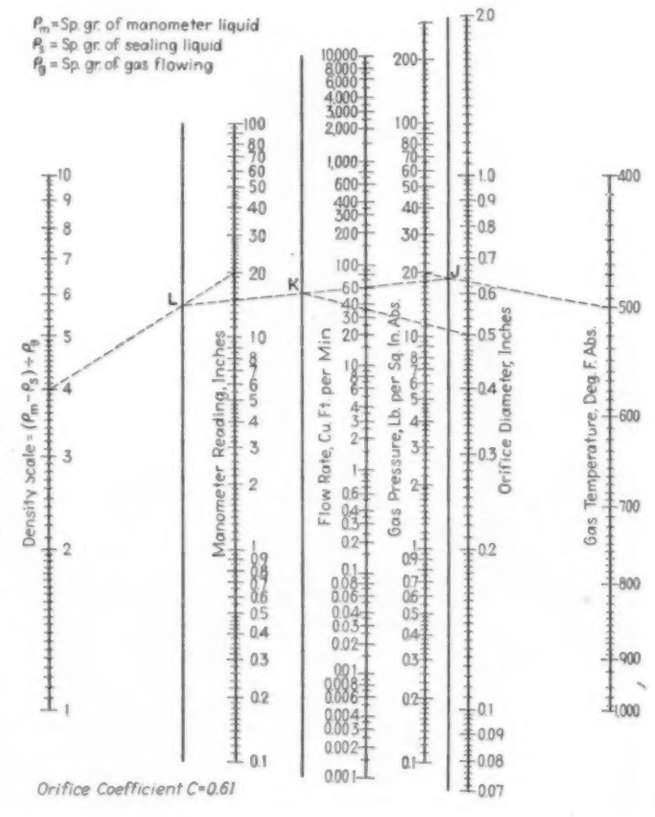
The chart of Fig. 1 is used for liquids. For example, where the specific gravities of the manometer liquid (mercury), sealing liquid and flowing liquid are respectively 13.6, 3.0 and 2.0, the value of the correction expression is $(13.6 - 3.0)/2.0 = 5.3$. Connect this value on Scale *A* with the manometer reading, 7.0 in., on *A'* and extend to *R* on the reference axis. Connect *R* with the orifice diameter, 0.4 in., and read the flow rate as 200 gal. per hour.

Fig. 2 is used for gases. For example, with specific gravities of the manometer and seal liquids of 5.0 and 1.0, and of the gas, 1 (air = 1), the value of the correction factor is $(5.0 - 1)/1 = 4$. With the gas at 500 deg. F. abs. and 20 lb. per sq. in. abs. pressure, and a manometer reading of 20.0 in., the flow rate is found as follows: Connect 4 on the density scale with 20.0 on the manometer scale and mark point *L*. Then connect 500 deg. F. abs. with the pressure, 20.0 lb. per sq. in. abs., and mark the point *J*. Connect *L* and *J* and mark the point *K*. Connect *K* and the orifice diameter, 0.5 in., the intersection with the flow rate scale showing a rate of flow of 36.0 cu. ft. per minute reduced to standard conditions of 32 deg. F. and atmospheric pressure.

**Fig. 1, Below—Nomographic chart for determining liquid flow rates from orifice meter readings**

**Fig. 2, Right—Nomographic chart for determining gas flow rates from orifice meter readings**


$\rho_m$ = Density of manometer liquid
$\rho_f$ = Density of liquid flowing
$\rho_s$ = Density of sealing liquid
Density Scale A = $(\rho_m - \rho_s) \div \rho_f$
Density Scale B = $(\rho_m - \rho_s)/\rho_f$
Note { A with A', B with B'
Manometer Reading, Inches, Scale A'
Manometer Reading, Inches, Scale B'
R
Liquid Flow Rate, Gallons per Hour
Orifice Diameter, Inches
Orifice Coefficient C = 0.61


$\rho_m$ = Sp. gr. of manometer liquid
$\rho_s$ = Sp. gr. of sealing liquid
$\rho_g$ = Sp. gr. of gas flowing
Density Scale = $(\rho_m - \rho_s) \div \rho_g$
L
K
J
Manometer Reading, Inches
Flow Rate, Cu. Ft. per Min.
Gas Pressure, Lb. per Sq. In. Abs.
Orifice Diameter, Inches
Gas Temperature, Deg. F. Abs.
Orifice Coefficient C = 0.61

Series A No. 1

# Chem. & Met. Report

ON

# Plant Lighting

## TO PLANT MANAGERS, SUPERINTENDENTS AND CHEMICAL ENGINEERS

THIS report is an engineering study of the important plant function of lighting. Practical information and useful data pertaining to the problems that are peculiar to chemical plants have been gathered together. The hazardous locations requiring special lighting equipment have been classified, and the explosion-proof and dust-tight fixtures for use in these places have been discussed. Attention has been called to the precautions governing the use of portable lamps and the illumination of spray booths. The fire hazard properties of certain flammable liquids, gases and volatile solids have been correlated. Industries and operations have been classified according to the types of hazards they present.

In addition, the report covers the special lamps and equipment which are required for applications: (1) where high external temperatures prevail, (2) where there is excessive vibration, (3) where the service is too rough for the standard incandescent lamp, (4) for indicators on remote control systems. Interesting features of the new infra-red lamps for drying synthetic enamels and lacquer films are summarized. The uses of fluorescent, polarized and ultra violet light sources as tools for inspection and other purposes in the process industries are described. The final specialized lighting problem discussed in the report is the prevention of sabotage in plant yards.

CHEMICAL & METALLURGICAL ENGINEERING

VOL. 47, No. 1, January 1940

TITLE OF REPORT Lighting of Chemical Plants

TO Plant Managers, Superintendents, Chemical Engineers

FROM Editors of Chem & Met

DATE January, 1940

# INTRODUCTION

This survey of lighting was undertaken at the request of numerous chemical engineers and others who are responsible for the proper functioning of chemical plants and for the welfare of the employees. As many of their letters have stated, there is an abundance of published information concerning the lighting of manufacturing plants in general, but little material is available in this literature relating to the problems that are of particular interest to the chemical processing plants.

The industry in almost all cases has a particularly difficult problem of lighting, for it not only has every problem that confronts the plant manufacturing automobiles, farm machinery, steel or other products, but it has many others that are of more vital concern.

It is hoped that the data and information that have been gathered together from such sources as the lamp and equipment manufacturers, the Underwriters' Laboratories, the Illuminating Engineering Society, the National Board of Fire Underwriters and the Committee on Flammable Liquids of the National Fire Protection Association will serve to determine whether any particular chemical or other material being processed or handled creates a hazardous location and if so the severity of the danger. From these same authorities may be obtained the answer to the questions concerning the type of lighting fixture that must be used in each of the several hazardous classifications, the rules governing the use of portable lamps, and the lighting of spray booths.

This study also attempts to instruct the engineer regarding the special lamps that are available for special purposes. It gives him the present-day accepted practice of lighting yards to provide protection against vandalism. And finally, it is hoped that the information about the new developments in lamps, equipment, and light sources will serve some useful purpose in planning a lighting system.

# RECOMMENDATIONS AND CONCLUSIONS

1. Developments of the past few years in sources of light and lighting equipment make it strongly advisable to have a survey made of the existing lighting system throughout your plant. A competent chemical engineer, working independently or in cooperation with an electrical engineer or lighting consultant, can handle this assignment. In all likelihood such an examination would show that a program of modernization would bring about a reduction in the number and in the seriousness of accidents to employees and plant equipment. As a result the efficiency of the operators would be increased and fewer mistakes would be made.

2. Make certain that the lamps and lighting equipment designed for a particular service are used in that service and for no other purpose or in no other location. For example, vibration lamps are not suitable for all rough services and rough-service lamps are not suitable for vibration service. (See p. 28.)

3. Loss of human life as well as loss of property by explosions and fires fully warrant the added expense incident to the installation of dust-tight or explosion-proof lighting fixtures in locations where dangerous materials are produced, processed or otherwise handled. Study carefully the detailed data on applications given in the following pages for hazardous chemicals, processes and industries.

4. In the design of lighting installations for hazardous locations, every effort must be made to eliminate the use of portable lamps.

5. The newer fluorescent, polarized and ultra-violet light sources are justifying their acceptance for special industrial purposes. It is time to familiarize yourself with their potentialities.

6. Infra-red lamps will often dry synthetic enamels and lacquers and other materials in from 5 to 15 per cent of the time formerly required by standard methods of drying according to the claims of their manufacturers. Recent installations are reported

7. Industrial sabotage and vandalism can be greatly reduced or often eliminated entirely by properly lighting plant premises that have been adequately fenced or otherwise protected against unwelcome intruders.

GOOD LIGHTING is a paying investment, not a needless luxury. In a properly illuminated working place accidents are less frequent, the employees work more efficiently and make fewer mistakes. As one authority has stated, "Human eyes are industry's most critical control devices. In many plant operations, efficiency and output rest to a greater extent upon good seeing than upon any other single factor. What's more, seeing conditions have a dual significance to good workmanship, since they may affect both the particular job being done, and, indirectly, the workman's entire attitude toward the job.

"Like others, lighting standards have risen sharply in recent years. A good lighting system today does not mean merely adding drop or spot lamps here and there, catering to the needs and complaints of an individual worker. Instead it means lighting 'tailored' to fit an entire operation as recommended by competent lighting engineers, after a careful survey of the entire layout of the plant or department." Researches in seeing reveal that good lighting can make it easier for the workman to perform critical seeing tasks, thus greatly improving his efficiency and at the same time conserving his energy, which is a good investment.

The chemical plant has many problems of lighting that are common to all manufacturing establishments, and in addition it has other problems that are to be found only in plants producing materials of this class. The dangerous nature of many of the chemicals require dust-tight or explosion-proof lighting fixtures, while the present European war with its threat of sabotage forces upon the chemical plant the necessity of doing a thorough job of flood lighting. Many of the specialized requirements of the industry are being met by taking advantage of such new developments in lighting as polarized light, ultra-violet light and fluorescent light.

*How much light is required.*—The desirable quantity of light for any particular installation depends upon the actual conditions, such as the accuracy of the operation, the fineness of the detail to be observed, the color of the material worked on, etc. Many installations supplying 20 to 50 footcandles of general lighting are now in use with supplementary illumination of from 100 to 250 foot-candles. These have proved to be profitable and practical as it is found the benefits derived more than offset the additional cost of operating such a system.

The footcandle values given in the accompanying table represent standards for various general requirements. They are based on observations of results in actual installations and on the adequacy of present equipment and methods to provide these values with safety and economy.

*General lighting is first consideration.*—The first step in planning a modern lighting system is to provide a reasonably uniform level of general lighting. Uniform lighting prevents bad shadows and contrasts and every work position enjoys the same degree of illumination.

The evenness of illumination from an overhead system is governed almost entirely by the relation of the spacing between the units to their height above the floor. The location of outlets determines largely how uniformly the light will be distributed over an area, just as the location of sprinkler heads regulates water coverage in case of fire. The layout of outlets will be governed by the arrangement of bays, columns, beams, and other construction details, fitting the layout as symmetrically as possible to the interior but keeping always within the limits of spacing as dictated by the ceiling height or height at which the lamps may be mounted. In general the spacing between units mounted close to the ceiling should not be greater than their mounting height above the floor.

*Supplementary lighting for critical seeing.*—Certain visual tasks require different methods of lighting and lighting is most efficient when designed to fit these tasks. In this connection a helpful analogy might be drawn between the fit of a person's clothes and the different types of lighting systems. When buying clothes, if one requires only protection from grease, dirt, etc., a pair of overalls, cut to fit a great number of people and designed to serve a variety of purposes, would be satisfactory. But they lack other requirements such as style, fit, appearance, and quality. In the same way a general, "over-all" system of lighting is designed to fit a great number of ordinary visual tasks but cannot possibly be satisfactory when it is required to provide light for some of the more difficult visual tasks. When you want the ultimate in style, fit, and appearance you have your clothes made for you alone by a tailor. Likewise, a particularly tough inspection job, the assembling of fine and expensive parts, or any one of the difficult visual tasks in the industrial world today require "tailor-made" lighting to help the worker's eyes perform their tasks with greater efficiency. This tailor-made industrial lighting is known among illuminating engineers as "supplementary lighting."

Contrary to the opinion of some, that the movement toward supplementary lighting is a reversion to the old practice of hanging a drop cord and a lamp wherever needed, supplementary lighting is used only in conjunction with a general lighting system. Early lighting practice employed "localized lighting" or light only upon the work. The outgrowth of this was general lighting over the entire work area, minimizing contrast between work and surroundings and enabling the worker to carry on his activities anywhere in the shop. The higher levels of illumination indicated by the science of seeing for the more difficult visual tasks, so numerous in the modern work-world, have indicated higher levels of illumination than are practicable to obtain economically from most systems of general lighting at the present time. The result of this trend has been the outgrowth of supplementary lighting or "general lighting plus."

The question of the contrast permissible between brightly lighted

**RECOMMENDED MINIMUM STANDARDS OF ILLUMINATION FOR INDUSTRIAL INTERIORS**

(These foot-candle values represent order of magnitude rather than exact level)

(Based on data prepared by Illuminating Engineering Society)

| | Foot-candles |
|---|---|
| Breweries: | |
| Brew House | 5 |
| Boiling, Keg Washing and Filling | 10 |
| Bottling | 15 |
| Chemical Works: | |
| Hand Furnaces, Boiling Tanks, Stationary Driers, Stationary and Gravity Crystallisers | 5 |
| Mechanical Furnaces, Generators and Stills, Mechanical Driers, Evaporators, Filtration, Mechanical Crystallisers, Bleaching | 10 |
| Tanks for Cooking, Extractors, Percolators, Nitrators, Electrolytic Cells | 15 |
| Clay Products and Cements: | |
| Grinding, Filter Presses, Kiln Rooms | 5 |
| Molding, Pressing, Cleaning and Trimming | 10 |
| Enameling | 15 |
| Color and Glazing | 20 |
| Glass Works: | |
| Mix and Furnace Rooms, Pressing and Lehr, Glass Blowing Machines | 10 |
| Grinding, Cutting Glass to Size, Silvering | 20 |
| *Fine Grinding, Polishing, Beveling, Etching and Decorating | 30-50 |
| *Inspection | 50-100 |
| Paper Box Manufacturing: | |
| Light | 10 |
| Dark | 20 |
| Storage | 5 |
| Paper Manufacturing: | |
| Beaters, Grinding, Calendering | 10 |
| Finishing, Cutting, Trimming, Paper Making Machines | 20 |
| Plating | 10 |
| Soap Manufacturing: | |
| Kettle Houses, Cutting, Soap Chip and Powder | 10 |
| Stamping, Wrapping and Packing, Filling and Packing Soap Powder | 20 |
| Storage Battery Manufacturing: | |
| Molding of Grids | 10 |
| Silk and Rayon Manufacturing: | |
| Soaking, Fugitive Tinting, and Conditioning or Setting of Twist | 10 |
| Winding, Twisting, Rewinding, and Coning, Quilling, Slashing | 30 |
| Warping (Silk or Cotton System) | |
| *On Creel, on Running Ends, on Reel, on Beam, on Warp at Beaming | 30-50 |
| Drawing-in | |
| *On Heddles | 100 |
| *On Reed | 100 |
| Weaving | |
| On Heddles and Reeds | 5 |
| On Warp Back of Harness | 10 |
| On Woven Cloth | 30 |

* Illumination of this order may in some instances be provided from a general lighting system. In other cases it will be found more economical to provide a combination of general lighting plus supplementary. Direction of light, diffusion, eye protection, study of direct and reflected glare, as well as elimination of objectionable shadows are all vitally important and must be considered.

work and less well-lighted surroundings is a subject still under investigation. In general, however, a ratio of 10 to 1 in brightness between work and surroundings is acceptable. The error of interpreting this ratio in foot-candles of illumination is common and responsible for faulty installations. The ratio of 10 to 1 if interpreted in foot-candles may result in a much greater contrast ratio particularly if the work be of a color or finish with a high reflection factor. Contrast limits are then exceeded with the result that the worker's eyes may become tired and efficiency suffers.

*New light sources.*—There are several types of light source that are proving to be extremely important tools for inspection and other purposes in the process industries. Fluorescent lamps offer daylight quality and a number of colors at high efficiencies. Perhaps the most significant feature of this type of lamp is the precise and efficient manner in which light of daylight quality and colored light can be produced. This daylight source makes inspection easier and more accurate where color comparisons are important.

Sources of large luminous area and relatively uniform brightness may be obtained by employing fluorescent lamps in suitably designed specular trough reflectors. Units of this type produce high illumination of good quality. Because the radiant heat from these lamps is only one-quarter that of incandescent lamps for equal foot-candles, a source of this type can furnish several hundred footcandles without the discomfort from heat formerly associated with high footcandles. This factor also decreases the load on cooling and air conditioning systems for equal illumination.

Polarized light is used occasionally in minimizing reflected glare from such surfaces as glass, linoleum, varnished wood, etc. It is only effective when incident light is at polarizing angle and an analyzing screen is used at the eye. This type of light is very good for detecting strains and defects in glass, mounted lenses, radio tubes, transparent plastics, etc. A polarizing screen and an analyzing screen must be used. The strained areas appear as color fringes in the material. This technic has been applied successfully with transparent working models of structures and machine parts to detect strained sections under operating conditions. Polarized light is being used also for the inspection of translucent inflated rubber articles.

Ultra violet light sources make it possible to identify products with marks visible only under these units, and not seen by the customer. This same type of light source is also made use of in inspection where it is necessary to determine the presence of fluorescent substances in other materials.

*Special lamps for special purposes.*—While it is not possible to discuss all of the lamps specifically designed for the various types of services, the following types of lamps deserve brief discussion.

Bake-oven lamps.—These sources have four special features not included in low-wattage general service lamps: (1) a special basing cement will withstand temperatures up to 550 deg. F., (2) the lead wires are welded to the base, (3) an asbestos insulation is placed between the leads in the base so that falling oxide will not cause a short circuit, and (4) bake-oven lamps undergo a special high-temperature exhaust, giving improved operation and longer life at the high external temperature involved. These lamps should also be used in applications where high external temperatures prevail.

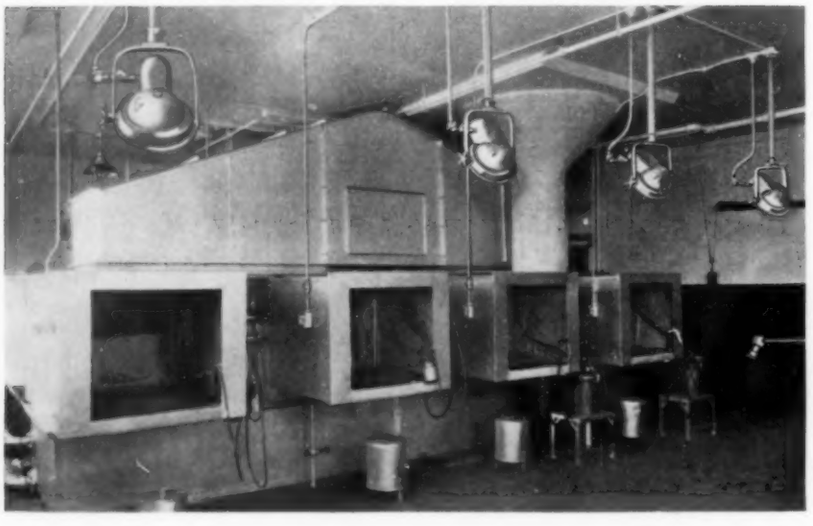
Vibration-service lamps. — Most lamps have coiled filaments made of a specially prepared tungsten having high sag resistance. However, vibration lamps, designed for use on high-speed machinery, and the like, where continuous high frequency vibrations would cause early failure of general service lamps, employ a more flexible tungsten filament. The sagging characteristic of the wire used allows the coils to open up under vibration, thus preventing short circuits between coils. These lamps are available in the 50 watt size. They should be used in a vertical, not in a horizontal position. Vibration lamps should not be used for general service lighting. It should be remembered that vibration lamps are not suitable for rough service, and rough-service lamps are not suitable for vibration service. Vibration resisting adapters utilizing a coiled spring to dampen vibration, are recommended where general service lamps are used under conditions of severe vibrations.

Rough-service lamps.—Filaments of lamps designed to withstand shocks and bumps are coiled on a very small mandrel, resulting in a relatively long coil which is then carefully mounted and held by many supports (the 50-watt rough service lamp has 16 supports). Because of the number of supports, the end logs will be higher and the efficiency lower. The center supports actually grip the filament and prevent slipping and thus possible shorting because of sudden shock. Rough service lamps find their principal application in extension cords and similar service where they must withstand severe shocks and bumps. They are available in the 50 and 100 watt sizes. This type of lamp is not recommended to stand steady vibration or general lighting service.

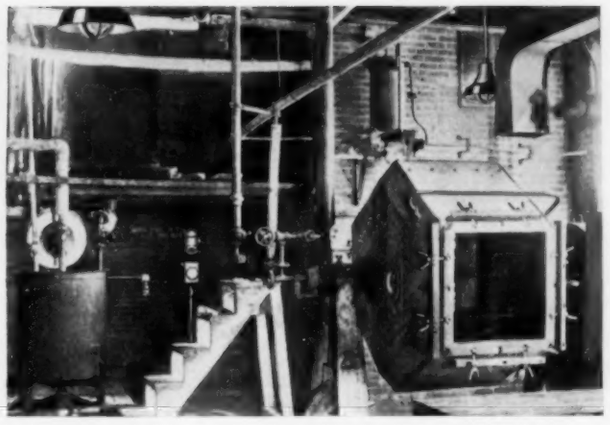
Indicator lamps.—In this era of modern control systems for telemetering, remote-control operation, etc., small indicator lamps play an important role. Some of the low-voltage lamps require filaments of such small diameter that ordinary drawing of the tungsten has to be followed by acid treatment to realize further reduction of the filament cross-section. Such small lamps require all the manufacturing precision of larger lamps and because of special treatments often cost more than higher wattage lamps.

Drying lamps.—A new lamp producing radiant energy in the near infra-red region of the spectrum is finding many uses in industry. Since the lamp is a source of heat, ordinary lamp economics do not apply in its design and use. The 250-watt, 115 volt

Explosion-proof lighting of a spray booth room



Explosion-proof lighting fixtures in a churn room of a rayon plant



A cistern room of a distillery protected by explosion-proof lighting equipment

lamp has the same physical dimensions as the 200-watt general service lamp and a special filament which is operated at a much lower temperature than the filaments of Mazda lamps. The low operating temperature results in a very long life.

The radiant energy emanating from the filament should be redirected by a polished reflector to the object being processed. The reflectors are mounted in banks spaced from 9 to 18 inches from the wet surface. It is reported that synthetic enamels and lacquers are being dried in from 5 to 15 per cent of the time formerly required by standard methods of drying. Satisfactory results have also been experienced in the drying of latex, paper, blueprints, resins, and other materials.

*Special Equipment for Hazardous Locations.*—Loss of human life as well as loss of property by explosions and fires fully warrant the added expense incident to the installation of dust-tight or explosion-proof lighting fixtures in locations where dangerous materials are produced, processed or otherwise handled. Safety is the first consideration when planning the lighting system for the chemical plant.

As the differences in explosive effects of many of the common materials are sufficient to call for different forms of construction of explosion-proof electrical equipment, it appears that the most practical and logical course is first to divide common materials into groups in accordance with the explosion hazards, and second to base the test requirements on the group in which the equipment is designed to operate.

The National Electric Code groups materials into four divisions: Class I covers flammable volatile liquids and gases. Class II includes metallic and non-metallic dusts. Class III covers locations where fibers or materials producing combustible flyings are handled, manufactured or used. Class IV deals with locations where fibers are stored.

A tentative grouping of common gases and vapors in respect to the explosive hazard has been worked out with the thought that it might be expanded or limited in the light of further experience, according to A. H. Nuckolls of the Underwriters' Laboratories. Four groups, A, B, C and D are included.

Group A is the most hazardous. It represents explosive properties of the order of those of acetylene. Groups B, C and D represent gases and vapors of successively lower explosion hazards. The hazards of group C are of the order of those of ether, and the hazards of Group D are of the order of those of gasoline.

The exact classification of hydrogen has not been finally determined, but it is tentatively placed in Group B. It may later be found to belong in Group C, Mr. Nuckolls tells us. As accumulation of explosion data increases, it may even be possible to reduce the number of groups. In the meantime, however, it is necessary in the interests of safety to employ the above grouping.

There are a number of other gases and vapors besides those of gasoline, which fall into Group D. Among these are methane, the vapors of various petroleum distillates, the various alcohols, acetone, common pyroxylin solvents and benzene.

## NATIONAL ELECTRIC CODE

(BASED ON ARTICLE 500—HAZARDOUS LOCATIONS, 1937 CODE)

Equipment for use in hazardous locations is tested according to classes of hazardous vapor or gas and air, or dust and air atmosphere as follows:

Class I, Group A, Atmospheres containing acetylene;

Class I, Group B, atmospheres containing hydrogen or gases or vapors of equivalent hazard such as manufactured gas;

Class I, Group C, Atmospheres containing ethyl ether vapor;

Class I, Group D, Atmospheres containing gasoline, petroleum, naphtha, alcohols, acetone, lacquer solvent vapors, and natural gas;

Class II, Group E, Atmospheres containing metal dust;

Class II, Group F, Atmospheres containing carbon black, coal or coke dust;

Class II, Group G, Atmospheres containing grain dust.

5001. Scope. The provisions of this article apply to locations in which the authority enforcing this code judges the apparatus and wiring to be subject to the conditions indicated by the following classifications. If the apparatus and wiring are installed in rooms or sections of the building in which the particular hazardous conditions do not prevail, such wiring and apparatus may be of the type approved for such locations.

5002. Special Precaution. The intent of this article is to require a form of construction of equipment, and of installation that will insure safe performance under conditions of proper use and maintenance. It, therefore, is assumed that inspection authorities and users will exercise more than ordinary care with regard to installation and maintenance.

5005. Class I. Classification. Class I locations are those in which flammable volatile liquids, highly flammable gases, mixtures or other highly flammable substances are manufactured, used, handled, or stored in other than their original containers.

This class may include such locations as some parts of dry-cleaning and dry-dyeing plants, pyroxylin plastic manufacturing plants, spray-painting establishments, flammable-gas plants, varnish-manufacturing plants, distilleries, rectifying and blending plants producing whiskey and other alcoholic beverage liquors, plants producing industrial alcohol, and

establishments or industries involving similar hazardous processes or conditions.

5006. Class II, Classification. Class II locations are those in which (1) combustible dust is thrown, or is likely to be thrown, into suspension in the air in sufficient quantities to produce explosive mixtures, or (2) those where it is impracticable to prevent such combustible dust from collecting in such quantities on or in motors, lamps, or other electrical devices that they are likely to become overheated because normal radiation is prevented.

This class may include such locations as some parts of flour mills, feed mills, grain elevators, starch plants, sugar, cocoa and coal-pulverizing plants, and establishments or industries involving similar hazardous processes or conditions.

5007. Class III, Classification. Class III locations are those in which easily ignitable fibers or materials producing combustible flyings are handled, manufactured or used, and which are hazardous through such fibers or flyings collecting on or being ignited by arcing contacts, resistors, lamps or similar apparatus. For combustible-fiber warehouses see sections 5071 to 5086.

This class may include locations such as some parts of cotton and other textile mills, combustible-fiber manufacturing plants, cotton gins, clothing manufacturing plants, cotton-seed mills, woodworking plants and establishments or industries involving similar hazardous processes or conditions.

5008. Class IV, Classification. Class IV locations are those in which easily ignitible combustible fibers are stored or handled (except in rooms where in process of manufacture) and which are hazardous through such fibers being ignited by arcing contacts, resistors, lamps, or similar apparatus.

## CLASS I—INSTALLATIONS

5011. General. In locations judged to be as described for Class I the following provisions shall be observed.

5019. Lighting Switches. Switches controlling lighting circuits shall be of a type approved for use in explosive atmospheres.

5020. Lighting Fixtures. Lamps in fixed position shall be enclosed in a manner approved for explosive atmospheres, and shall be properly protected by substantial metal guards or other means where exposed to breakage. Lamps shall not be of the pendant type unless supported by and supplied through hangers of rigid conduit or flexible connectors approved for explosive atmospheres. If rubber-covered conductors are used, they shall have insulation not less than $\frac{3}{64}$ inch thick. Rigidly mounted fixtures shall be strongly supported.

5021. Portable Lamps. Sufficient general illumination shall be provided by fixed lighting units to eliminate, so far as possible, the need for portable lamps. If portable lamps are necessary, they shall be enclosed in a manner approved for explosive atmospheres and shall be protected against breakage by approved types of guards. Lampholders for portable lamps shall be of moulded-composition or other approved material and of the keyless type with no exposed metal parts.

5022. Flexible Cord. If necessary to use portable lamps or portable appliances, flexible cord designed for hard usage such as Type S or Type PA shall be used. Such a flexible cord shall contain one extra insulated conductor to form a grounding connection for metal lamp guards, motor frames, and all other exposed metal portions of portable lamps and appliances. The outer covering of the grounding conductor shall be finished to show a green color. Portable cords connected direct to supply conductors shall be securely supported so that the probability of a break in the conductors at this point will be minimized.

5024. Spray Booths. No motor, lamps, or lighting future of any type shall be located within spray booths, in ventilating ducts connected therewith, nor in any location where there is a possibility of the spray lodging upon them. The auxiliaries of mercury-vapor lamps shall be located at least ten feet from spray-booth working faces.

## CLASS II—INSTALLATION

5051. General. Where conditions are judged to be as described for Class II, the following provisions shall be observed.

5059. Illumination. Sufficient general illumination shall be provided by fixed units to eliminate so far as possible any need for portable lamps.

a. Lighting Fixtures. Lamps in fixed positions shall be enclosed in a manner approved for excluding dust, and where exposed to mechanical injury, shall be protected by substantial guards. Heavy fixtures used as pendants shall be supported by conduit hangers or chains. If rubber-covered conductors are used, they shall have insulation not less than $\frac{3}{64}$ inch thick. Lampholders shall be of the keyless type.

If light is required for the interior of bins, hoppers, elevators, conveyors, and similar equipment or construction, it is recommended that such light shall, if practicable, be supplied by lamps enclosed in dust-tight globes properly protected against mechanical injury and mounted flush in the walls or floors of the equipment or construction. No wiring or fixtures should be permitted inside of bins, hoppers, elevators, or conveyors.

b. Portable Lamps. Portable lamps shall be enclosed in dust-tight globes properly protected by substantial metal or other approved types of guards. Lampholders for portable lamps shall be of moulded-composition or other approved material and of the keyless type with no exposed metal parts.

## CLASSES III AND IV—INSTALLATION

5071. General. In locations judged to be as described for Classes III and IV, the following provisions shall be observed.

5079. Illumination. Sufficient general illumination shall be provided by fixed units to eliminate so far as possible any need for portable lamps.

a. Lighting Fixtures. Where there is a possibility of lint or flyings collecting on lamps in fixed positions, the lampholders and lamps shall be enclosed in dust-tight fixtures so designed that in the event of a burnout of the lamp or lampholder no spark or hot metal can escape from the enclosure. When exposed to mechanical injury, a substantial metal or other approved type of guard shall be provided to prevent breakage. Lamps shall not be of the pendant type unless supported by and supplied through hangers of rigid conduit or other metal tubing of equivalent thickness. Lampholders shall be of the keyless type and shall be wired with wire not less than No. 14 gauge in such a manner that no conductors will be exposed.

b. Portable Lamps. Portable lamps shall be enclosed in dust-tight globes properly protected by substantial metal or other approved types of guards. Lampholders for portable lamps shall be of moulded-composition or other approved material and of the keyless type with no exposed metal parts.

5080. Cords for Portables. If necessary to use portable lamps or portable appliances, flexible cord approved for hard usage, such as Type S or Type PA, shall be used. Such a flexible cord shall contain one extra insulated conductor, which shall be properly connected to form a grounding connection for metal lamp guards, motor frames, and all other exposed metal portions of such portable lamps and appliances. Cords connected directly to supply conductors shall be securely supported so that the probability of a break in the conductors at this point will be minimized. The outer covering of the grounding conductor shall be finished to show a green color.

A fact that may be easily overlooked is that a piece of equipment that has been investigated for use in Class I, Group D, hazardous locations only is not necessarily safe for use in Class II, Group G hazardous locations. Conversely a fixture that has been listed for use in Class II, Group G hazardous locations has not been investigated with respect to use in Class I, Group D hazardous locations and may not prevent ignition of surrounding flammable and explosive gases or vapors if a gas or vapor air explosion occurs within it. In view of this a fixture should be used only in the hazardous location for which it is designed and intended to be used as shown in its listing by the Underwriters' Laboratories.

Since it is not practical to keep the vapors or gases out of inclosures, requirements have been drawn specifying a construction which will withstand internal explosions without rupture or permanent distortion and with adequate factor of safety and which will prevent flame of such explosions from propagating through the joints of assembly to ignite surrounding flammable gases or vapors.

In the design of lighting installations for hazardous locations, every effort should be made to eliminate the need for portable lights, wrote C. W. Gustafson, chairman of the Committee which prepared the chapter on hazardous locations for the National Electric Code in a series of articles in *Elec-*

# FIRE-HAZARD PROPERTIES OF CERTAIN FLAMMABLE LIQUIDS, GASES AND SOLIDS

Based on Data Compiled by Committee on Flammable Liquids of the National Fire Protection Association*

| MATERIAL | Flash Point deg. F. | Ignition Temp. deg. F. | Explosive Limits per cent in Air | | Vapor Density |
|---|---|---|---|---|---|
| | | | Lower | Upper | |
| Acetaldehyde | −17 | 365-716 | 4 | 57 | 1.52 |
| Acetic Acid | 104-115 | 932 | | | 2.07 |
| Acetic Acid (Glacial) | 107-111 | 800-925 | 4 | | 2.07 |
| Acetic Anhydride | 110-141 | 600-675 | | | 3.52 |
| Acetone | −4-36 | 932-1292 | 2-3 | 9-13 | 2.00 |
| Acetyl Chloride | 40 | | | | 2.71 |
| Acetylene | gas | 763-959 | 2.5-3.2 | 52.2-82 | 0.90 |
| Allyl Alcohol | 70-72 | 713 | 2.4-3.0 | | 2.00 |
| Aluminum Paint | 0-70 | | | | |
| Ammonia (anhydrous) | gas | 1204 | 16-16.1 | 25-27 | 0.59 |
| Amyl Acetate[4] | 70-92 | 710-815 | 1.1 | | 4.49 |
| Amyl Alcohol[2] | 92-130 | 660-768 | 1.2-1.48 | | 3.04 |
| Aniline | 79-183 | 987-1418 | | | 3.22 |
| Anthracene | 430 | 881 in $O_2$ | | | 1.15 |
| Asphalt | 400 | | | | |
| Benzaldehyde | 144-148 | 356-377 | | | 3.66 |
| Benzine | <6-5 | 475 | 1.1-2.6 | 4.8-5.9 | 4.48 |
| Benzoic Acid | 250-268 | | | | 4.21 |
| Benzol[3] | −17-50 | 932-1364 | 1.4-3 | 4.7-8 | 2.77 |
| Benzyl Acetate | 216 | | | | 5.17 |
| Benzyl Alcohol | 212 | 817 | | | 3.72 |
| Benzyl Chloride | 140 | | | | 4.36 |
| Blast Furnace Gas | gas | | 35 | 74 | |
| Bromobenzine | 149 | | | | 5.41 |
| Bronzing Liquid | 80 | | | | |
| Butane | gas | 805-1058 | 1.5-1.9 | 5.7-8.5 | 1.95 |
| Butyl Acetate | 66-88 | 700-860 | 1.7-1.9 | | 4.00 |
| Butyl Alcohol[2] | 73-111 | 637-842 | 1.7 | 18.0 | 2.55 |
| Butyl Cellosolve | 140-165 | | | | 4.07 |
| Butylene | gas | | 1.7 | 9.0 | 1.94 |
| Butyl Ether — n | 100 | | | | 4.48 |
| Butyl Lactate | 160 | | | | 5.04 |
| Butyraldehyde | <20-64 | | | | 2.48 |
| Butyric Acid | 170 | | | | 3.04 |
| Butyric Anhydride | 190 | | | | 5.38 |
| Camphor | 125-180 | | 0.61 | 3.5 | 5.24 |
| Carbitol | 210 | | | | 4.62 |
| Carbitol Acetate | 225 | | | | 6.07 |
| Carbon Disulphide[11] | −40-4 | 212-338 | 1.0-4.1 | 50 | 2.64 |
| Carbon Monoxide | gas | 1177-1497 | 12.5-16.6 | 71.2-75 | 0.97 |
| Carbon Remover, Liquid | <80 | | | | |
| Castor Oil | 487-505 | | | | |
| Cellosolve | 111 | | | | 3.10 |
| Celloscive Acetate | 127-142 | | | | 4.72 |
| Chlor Benzol | 81-102 | | | | 3.88 |
| Chloroethyl Acetate | 129-153 | | | | 4.22 |
| Cleaning Solvents of Kerosene Class[1] | 100-120 | 480-495 | 1.1 | 6.0 | |
| Coal Gas | gas | 1197-1200 | 5.3-8 | 19-31 | |
| Coal Tar Oil | <80 | | | | |
| Coconut Oil | 420-548 | | | | |
| Collodion | −25-0 | | | | |
| Corn Oil | 480 | | | | |
| Cottonseed Oil (Refined) | 338-582 | 650-800 | | | |
| Creosote Oil | 165 | 1022 | | | |
| Cresol | 177-187 | | | | 3.72 |
| Cresylic Acid | 110 | | | | |
| Croton Aldehyde | 55-127 | | | | 2.41 |
| Cumol | 102-126 | | | | 4.13 |
| Cyclohexane | 1 | | 1.3 | 8.3 | 2.90 |
| Denatured Alcohol[3] | 40-61 | 700-810 | 3.5 | 18.0 | 1.60 |
| Diacetone | 40-131 | | | | 4.00 |
| Dibutylphthalate | 316-360 | | | | 9.58 |
| Dichlorethyl Ether | 172 | | | | 4.93 |
| Dichlorobenzene | 153-172 | | | | 5.07 |
| Dichlorethylene | 57-63 | 856 | 5.6-10 | 11.4-13 | 3.35 |
| Diethylene Glycol | 286 | 444 | | | 3.66 |
| Diethyl Phthalate | 284 | | | | 7.66 |
| Dimethyl Aniline | 142-169 | 700-750 | | | 4.17 |
| Dinitro Benzene | 302 | | | | 5.79 |
| Dinitrochlorobenzene | 369 | | | | 6.98 |
| Dioxan | 65 | | | | 3.03 |
| Diphenylamine | 307 | | | | 5.82 |
| Diphenylmethane | 266 | | | | 5.79 |
| Dodecane | 165 | | 0.6 | | 5.86 |
| Ethane | gas | 950-1166 | 3.0-3.3 | 10.6-15.0 | 1.03 |
| Ethyl Acetanilide | 126 | | | | 4.72 |
| Ethyl Acetate | 23-41 | 800-925 | 2.3-2.5 | 11.4-11.5 | 3.04 |
| Ethyl Acetoacetate | 184 | | | | 4.48 |
| Ethyl Alcohol[3] | 48-90 | 700-1036 | 2.8-4.0 | 9.5-19.0 | 1.59 |
| Ethyl Benzene | 50-61 | | | | 3.66 |
| Ethyl Bromide | | 952 | 6-7 | 11 | 3.76 |
| 2-Ethyl Butyl Alcohol | 137 | | | | 3.52 |
| Ethyl Cellosolve | 104 | 460 | | | 3.10 |
| Ethyl Chloride | −37-0 | 966 | 3.6-4.3 | 11.2-15 | 2.22 |
| Ethylene | gas | 1008-1110 | 3.0-4.2 | 14.1-35 | 0.97 |
| Ethylene Chlorhydrin | 140 | | | | 2.78 |
| Ethylene Diamine (anhydrous) | 93 | | | | 2.07 |
| Ethylene Dichloride[5] | 57-70 | | 6 | 16 | 3.42 |
| Ethylene Glycol | 232-241 | 775-781 | 3.2 | | 2.14 |
| Ethyl Ether[10] | −49-<20 | 356-649 | 1-3 | 5.2-48 | 2.56 |
| Ethyl Glycol | 104 | | | | 3.10 |
| Ethyl Lactate | 115-117 | | | | 4.41 |
| Ethyl Methyl Ether | −35 | 374 | 2 | 10.1 | 2.07 |
| Ethyl Methyl Ketone | 30 | | 1.97-2.0 | 10.2-12 | 2.41 |
| Ethyl Nitrate | 50 | | 3.8 | | 3.14 |
| Ethyl Nitrite | −31 | 194 | 3 | 50 | 2.59 |
| Ethyl Propionate | 54-60 | | | | 3.52 |

| MATERIAL | Flash Point deg. F. | Ignition Temp. deg. F. | Explosive Limits per cent in Air | | Vapor Density |
|---|---|---|---|---|---|
| | | | Lower | Upper | |
| Fish Oil | 150-420 | | | | |
| Flavoring Extracts | <80 | | | | |
| Formaldehyde | 90 | | | | 1.03 |
| Fuel Oil | 95-150 | | | | |
| Furfural | 132-151 | 600-675 | 2 | | 3.31 |
| Gas Oil | 175-230 | 637 | | | |
| Gasoline[9] | −45-20 | 500-570 | 1.3-1.4 | 6 | 3-4 |
| Glycerine | 349-350 | 650-932 | | | 3.17 |
| Heptane | 25-63 | 452-545 | 0.95-1.1 | 3.6-6 | 3.45 |
| Hexahydrotoluol | 25 | | | | 3.38 |
| Hexane | −24-0 | 479-909 | 1.1-1.3 | 4.2-6 | 2.97 |
| Hexone | 74 | | | | 3.45 |
| Hydrocyanic Acid | | | 5.6-12.75 | 27-40 | 0.9 |
| Hydrogen | gas | 986-1143 | 4.1-9.5 | 66.5-80 | 0.069 |
| Hydrogen Sulphide | gas | 482-534 | 4.3-4.5 | 45.5-46 | 1.17 |
| Hydroquinone | 329 | | | | 3.81 |
| Illuminating Gas | gas | 1094 | 5-7 | 21-31 | |
| Kerosene[8] | 81-140 | 482-563 | 1.1-1.2 | 6.0 7.0 | 4-8 |
| Lacquer | 0-80 | | | | |
| Lanolin | 460 | | | | |
| Lard Oil | 398-600 | 650-750 | | | |
| Lead Tetramethyl | | | 1.80 | | 9.22 |
| Linseed Oil | 378-662 | 650-750 | | | |
| Liquid Metal Polish | <80 | | | | |
| Lubricating Oil | 392-608 | | | | |
| Methane | gas | 999-1452 | 4.9-6.2 | 12.7-16 | 0.55 |
| Methyl Acetate | 3-40 | 850-953 | 4.1 | 13.9-14 | 2.56 |
| Methyl Acetoacetate | 180 | | | | 4.00 |
| Methyl Alcohol | 30-90 | 800-900 | 6-7.8 | 18-36.5 | 1.11 |
| Methyl Amyl Alcohol | 114 | | | | 3.52 |
| Methyl Bromide | | 999 | 13.5 | 14.5 | 3.27 |
| Methyl Cellosolve | 105-107 | 551 | | | 2.62 |
| Methyl Cellosolve Acetate | 132 | | | | 4.07 |
| Methyl Chloride | gas | 1170 | 8-8.3 | 17.2-19.7 | 1.74 |
| Methylcyclohexanone | 118 | | | | 4.86 |
| Methyl Cyclohexyl Acetate | 147 | | | | 5.37 |
| Methylene Chloride | | 1224 | | | 2.93 |
| Methyl Ether | −42 | | | | 1.59 |
| Methyl Formate | | 853-928 | 4.5-6 | 20-22.7 | 2.07 |
| Methylhexalin | 154 | | | | 3.93 |
| Methyl Propionate | 28 | | | | 3.03 |
| Methyl Propyl Carbinol | 105 | | | | 3.03 |
| Methyl Salicylate | 219 | 850-950 | | | |
| Monoethanolamine | 200 | | | | 2.10 |
| Naphtha | −45-110 | 490-531 | 1.2 | 6.0 | |
| Naphthalene | 185-187 | 500 in $O_2$ | 0.9 | | 4.42 |
| Naphtha, Petroleum | <80 | | | | |
| Naphtha ("Solvent") | 60 | 900 | 1.3 | 8.0 | |
| Naphtha V. M. & P. | −40-30 | 500-520 | 1.2 | 6.0 | |
| Naphthol, Beta | 307-322 | | | | 4.97 |
| Naphthylamine | 315 | | | | 4.93 |
| Natural Gas | gas | | 4.8-5.0 | 13.5-15 | |
| Nitrobenzene | 188-198 | 900-950 | | | |
| Nitrocellulose (Wet with Solvent) | 40 | | | | |
| Nitrochlorobenzene | 261 | | | | 5.43 |
| Nitrotoluol — para | 223 | | | | 4.72 |
| Olive Oil | 419-505 | 650-800 | | | |
| Paint, Bronze or Gold | 0-70 | | | | |
| Paint, Liquid | 0-80 | | | | |
| Palm Kernel Oil | 398 | | | | |
| Palm Oil | 323-421 | 600-752 | | | |
| Paraffin Oil | 220-444 | | | | |
| Paraldehyde | 63 | 410 | 1.3 | | 4.55 |
| Pentane | <0 | 593 | 0.25-2.5 | 4.5-7.5 | 2.48 |
| Petrohol | 59-66 | 845-895 | | | |
| Petroleum Ether[9] | −69-4 | 475-624 | 1.4 | 5.9 | 2.5 |
| Phenol | 172-174 | 1319 | | | 3.24 |
| Phthalic Anhydride | 330 | | | | 0.21 |
| Pine Oil, Steam Distilled | 138-148 | | | | |
| Ponsolve[7] | 49 | 835 | | | |
| Propane | gas | 871-1090 | 2.0-2.4 | 7.0-9.5 | 1.52 |
| Propyl Acetate | 58 | | 2.0 | | 3.52 |
| Propyl Alcohol, Normal[3] | 72-114 | 700-941 | | | 2.07 |
| Propylene | gas | 927-952 | 2.0-2.2 | 9.0-9.7 | 1.45 |
| Propylene Dichloride | 70 | | | | 3.89 |
| Propyl Ether, Iso | <32 | | | | 3.52 |
| Pyridine | 68-80 | 900-1100 | 1.8 | 12.4-12.5 | 2.73 |
| Pyroxylin Solution | <80 | | | | |
| Rape Oil | 410-581 | | | | |
| Red Oil, Distilled | 364 | | | | |
| Resorcinol | 306 | | | | 3.79 |
| Rosin Oil | 257-270 | | | | |
| Soy Bean Oil | 566 | | | | |
| Sperm Oil | 428-486 | 586 | | | |
| Tin Tetramethyl | | | 1.90 | | |
| Toluidine | 185-202 | 900-1000 | | | |
| Toluol[3] | 35-86 | 986-1490 | 1.0-3.0 | 6.0-7.0 | 3.14 |
| Triethanolamine | 355 | | | | 5.14 |
| Tung Oil | 552 | | | | |
| Turpentine[3] | 90-113 | 464-489 | 0.8 | | 4.7 |
| Turpentine Substitute | 90-110 | 480 | 1.2 | 6.0 | 4.0 |
| Varnish | 60-130 | | | | |
| Varnish Shellac | 40-70 | | | | |
| Vinyl Chloride | | | 4 | 22 | 2.15 |
| Water Gas | gas | | 6-12.5 | 55-70 | |
| Whale Oil | 455-515 | | | | |
| Xylene | 76-122 | 900-1150 | 1.0-1.2 | 5.3-6.0 | 3.66 |

*Table from which these data were taken should be consulted for references to original literature sources.

Underwriters' Laboratories' Classification is standard for grading relative hazards of various flammable liquids. It is based upon the following scale: ether 100, gasoline 90-100, alcohol (ethyl) 60-70, kerosene 30-40, paraffin oil 10-20. [1]30-40, [2]40, [3]40-50, [4]55-60, [5]60-70, [6]70, [7]75, [8]75-80, [9]95-100, [10]100, [11]110.

*trical Contracting*. This requires more than ordinary study and skill, especially where numerous machines are installed or where the character of the work done requires light of a high value. However, in spite of the best intentions, portable lights will be used and hence, the rules provide for the construction and installation of both fixed and portable units.

Motors, lamps, switches, or other electrical devices are not permitted to be installed in spray booths, in ducts connected to them, nor in any location where there is a possibility of the spray collecting on them. The code also requires that the auxiliaries of mercury vapor lamps, which include open resistors, be offset a distance of at least 10 ft. from the working face of the spray booth.

Compliance with these requirements is especially important when pyroxylin lacquers are used as the residue or dust of such lacquers break down as low as 212 deg. F., or much below the temperature of even an explosion-proof lighting fixture. Spray booth interiors may be lighted by means of flood lights or vapor-proof angle reflectors placed outside of the booth or by explosion-proof lighting fixtures placed behind and outside of wire glass panels in the walls of the booth.

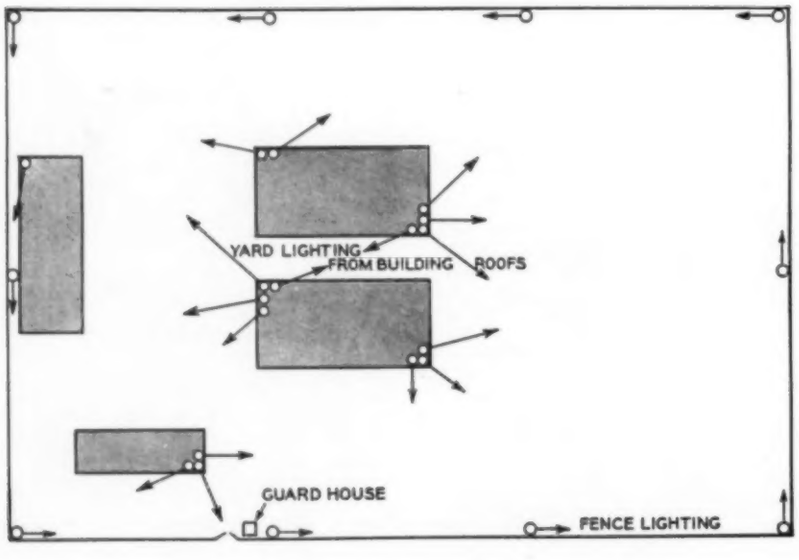
*Lighting to prevent sabotage.*—Proper lighting of plant yards is particularly important when conditions throughout the world are so very unsettled. Chemical plant yards in particular should be lighted to guard against the dangers of sabotage. On the other hand, plant yards require lighting at all times for work areas, for drives and passageways, for parking areas and for protection from casual trespassers. Floodlighting projectors properly placed and of the right type will, in many cases, serve all these purposes, but the projectors must be selected and placed for the type of lighting required.

Lighting for protection is important because of the increase in vandalism around dark yards. Vital spots are: space between buildings, near fences, entrances, power plant, alley ways between buildings and fence.

Lighting should be based upon poor visibility such as fog or smoke conditions. Underground wiring with a minimum of outside wiring is essential. Lights must be out of easy reach. Fences should be painted white.

Good lighting is just as good as a guard. Narrow beam projectors (1000 watt lights) at corners and at 300-ft. intervals will throw a ring of light around the yard. If there is a patrolling watchman, all of the light should be projected in one direction so as not to cause glare and reduce his visibility. If there is no patrol, units may point toward each other and the distance between poles may be doubled. The same purpose may be accomplished by placing projectors on the roofs of buildings and directing them to the boundaries and particularly to entrances near railway sidings and other unguarded points of easy access. Light should never be directed toward the buildings unless the entire building is well floodlighted, if a watchman is inside the building, because the glare prevents him from seeing any approaching trespassers. A lighted building is a very good background for a watchman located some distance away from the building and it also deters an intruder from approaching the building.

Lighting area to provide protection against sabotage




## CLASS OF HAZARD PRESENTED IN SOME INDUSTRIES AND OPERATIONS

| Industries | *Class of Hazard I | II | III | IV |
|---|---|---|---|---|
| Automobile Mfg. | X | | X | X |
| Breweries | X | X | | |
| Bulk Stations (Oil) | X | | | |
| Candle Making | X | | | |
| Chemical Plants | X | X | | |
| Coal Mining | X | X | | |
| Coke Plants | X | X | | |
| Cold Storage | X | | | |
| Cordage, Rope & Twine | | | X | X |
| Cotton Compresses, Gins & Mills | | | X | X |
| Cotton Nitrating Plants | X | | X | X |
| Department Stores | X | | X | X |
| Disinfectant Works | X | | | |
| Distilleries | X | X | | |
| Dry Cleaning and Oil Separation | X | | X | X |
| Dye Works | X | | X | X |
| Ether Plants | X | | | |
| Feed Mills | | X | X | X |
| Fertilizer Plants | X | X | | |
| Flavoring Extract Plants | X | | | |
| Flour and Cereal Mills | | X | X | X |
| Food Processing | X | X | X | X |
| Furniture Plants | X | | X | X |
| Garages | X | | | |
| Garments—Boots, Shoes, Hats, Clothes | X | X | X | X |
| Gasoline Stations | X | | | |
| Gas Plants | X | X | | |
| Grain Elevators | | X | X | X |
| Hangars—Aeroplane | X | | | |
| Hospitals | X | | | |
| Ice Plants | X | | | |
| Ink Factories | X | X | | |
| Insulated Wire Plants | X | | | |
| Jewelry Mfgrs | X | | | |
| Lacquer Mfgrs | X | | | |
| Leather Mfgrs | X | X | X | X |
| Liquor Distilleries | X | X | | |
| Machine Shops | | X | | |
| Marine Oil Terminals & Bulk Stations | X | | | |
| Mattress Factories | | X | X | X |
| Milling | | X | X | X |
| Oil Cloth—Incl. Linoleum, etc. | X | X | X | X |
| Oiled Clothing Mfgrs | X | X | X | X |
| Oil Refining—Animal, Veg. and Mineral | X | | | |
| Oil Separation Plants | X | | | |
| Paint Shops, Varnish Plants | X | X | | |
| Paper Mfg. | X | | X | |
| Perfumery Laboratories | X | | | |
| Photogravure Shops | X | | | |
| Power Plants | | X | | |
| Printing Plants | X | X | | |
| Pyroxlin Plastic (Celluloid) Plants | X | X | X | X |
| Rayon Plants | X | X | X | X |
| Rubber Goods | X | X | | |
| Sewage Disposal | X | | | |
| Soap Plants | X | | | |
| Storage Battery Factories | X | | | |
| Tanneries (Leather) | | X | X | |
| Textile Industry | | X | X | X |
| Warehouses, Grain and Other Combustibles | X | X | X | X |
| Wax Solvent Plants | X | | | |
| Wood Distillation Plants | X | | | |
| Woodworking and Wood Flour Plants | | X | | |
| **Operations** | | | | |
| Boiler and Fuel Handling Rooms | X | X | | |
| Cleaning and Wash Racks | X | | | |
| Coal and Coal Tar Distillation | X | X | | |
| Coating (Cloth and Paper) | X | | | |
| Crushing | | X | | |
| Cutting, Punching, Stamping | | X | X | |
| Dipping Tanks and Vats | X | | | |
| Distillation | X | | | |
| Dusty Processes: | | | | |
| Cereals, Cocoa, Starch | | X | | |
| Feed, Flour, Grain | | X | | |
| Fertilizers | | X | | |
| Sugar | | X | | |
| Sulphur Dust | | X | | |
| Carbon Black, Lamp Black | | X | | |
| Coal Dust, Coke Dust | | X | | |
| Aluminum, Magnesium | | X | | |
| Bronzing Powder | | X | | |
| Fermentation Products (Alcohols) | X | | | |
| Grain Cleaning, Conditioning and Handling | X | X | X | X |
| Grinding, Planing, Polishing, Sawing | | X | X | |
| Handling, Loading and Transferring | | X | X | X |
| Lacquer Plasticizers and Softeners | X | X | | |
| Lacquer Solvents | X | | | |
| Metal Cleaning and Finishing | | X | | |
| Molding and Pressing | X | X | X | |
| Pulverizing | | X | | |
| Refrigeration | X | | | |
| Rolls and Finishing Processes | | X | X | |
| Spray Booths | X | | | |
| Stocking and Storing | X | X | X | X |
| Tank and Bin Emptying | X | X | X | |
| Vaporizing | X | | | |

* See pages 29 and 30.

# Machinery, Materials and Products

## Remote-Motored Fan

A NEW propeller-type fan with the motor entirely outside of the air stream has been announced by the Hartzell Propeller Fan Co., Piqua, Ohio. Designed for installation in locations where the motor must be removed from the air stream on account of the presence of flammable fumes, extreme heat or abrasive or corrosive elements, the new fan employs this company's Charavay overlapping ring which is said to assure high fan efficiency by preventing backflow of air at the propeller tips. The motor base is welded to this ring and also to a shield which encases the belt. The propeller shaft bearings are entirely inclosed within a housing welded to the bottom of the belt shield. A hinged motor base facilitates belt tension adjustment. The new fan is built in sizes from 17 to 28 in. propeller diameter, with other sizes to special order.

## U-Bolt Gate Valve

AN INTERESTING FEATURE of a new U-bolt gate valve known as the Duo-Bolt, introduced by the Ohio Injector Co., Wadsworth, Ohio, is the fact that its conventional U-bolt may instantly be replaced with standard stock bolts, thus lowering replacement and maintenance costs and reducing the necessary parts inventory, according to the manufacturer. This new valve features a special and extra large drain duct to allow fluid to flow rapidly back into the body when piping operations are discontinued. The self-seating type horseshoe-shaped slip-on wedge used as the gate is of standard taper. In all-iron valves, the wedge is of malleable iron, while steam bronze is employed in bronze-mounted valves.

## Enameled Building Materials

NEW-TYPE porcelain enameled roofing and siding materials for the construction of buildings have been announced by Porcelain Steels, Inc., Cedar and Ashland Road, Cleveland, Ohio. These materials, which are made under the Kor-Lok patents, employ an interlocking type of construction in which all fastenings are concealed so that there are no expo ed nail holes. The corrugated steel used is porcelain enameled in various colors as well as gray and black. A white under-surface for roofs is available for industrial operations requiring light reflectance. These materials are stated to be fireproof and to yield a lifetime of service without painting. Only occasional cleaning with soap and water is required.

First of the new buildings to employ this construction material was a new factory for the Ferro Enamel Corp., Cleveland, Ohio. This company was also, to a large extent, responsible for the development of the enamels used in the new covering materials. In addition to its corrugated roof, the new Ferro building employs other porcelain enameled features including a stack, gables, trim, gutters, window-sash and doors.

## Variable Speed Motor

WHAT IS DESCRIBED as an entirely new principle in alternating-current adjustable-speed motors is the new Ajusto-Spede motor recently announced by the Louis Allis Co., Milwaukee, Wis. This motor, which is of the constant-torque type, consists of a combination of an eddy current clutch and a standard constant-speed a.c. squirrel-cage motor. No mechanical contact between driving and driven members of the unit is required. Speed variations are obtained by controlling the magnetic excitation of the clutch, thereby obtaining any desired slip. The unit permits gradual or quick acceleration of load, as desired, and is claimed to absorb torsional impulses and vibrations. Speed variation from zero to full speed at full-load torque may be obtained. The unit is claimed to operate continuously at low speeds without overheating and is capable of remote control if desired. Clutches of this type from fractional horsepower to several thousand horsepower are available.

In the cross-sectional drawing, the driving drum runs constantly at motor speed. When full d.c. excitation is supplied to the coil, the clutch element rotates at practically motor speed. As excitation is reduced, the slip between the drum and the clutch increases in order to hold the torque constant. The clutch member itself is keyed to the output shaft. Efficiency of the clutch is claimed to be from 95 to 97 per cent at maximum excitation.

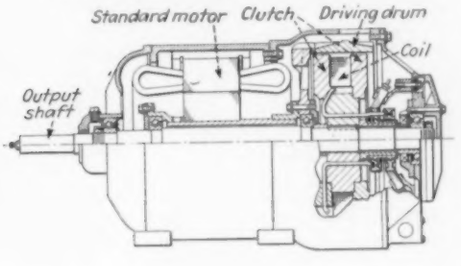
**Remote-motored propeller fan**

## New Products

A NEW MATERIAL known as Santobrite, used for the preservation of rubber latex, has been announced by the Organic Chemicals Division of Monsanto Chemical Co., St. Louis, Mo.

**New Ferro Enamel plant at Cleveland employing corrugated steel porcelain-enameled roof**

**Cross-section of Ajusto-Spede motor**



According to the manufacturer, tests are claimed to have proved that 0.3 per cent of this material with 0.1 per cent of ammonia, based on the weight of fresh latex, will effectively preserve the latex against biological deterioration, without in any way adversely affecting subsequent compounding and manufacturing procedure. This material, sodium pentachlorphenate, is said to produce a latex having none of the undesirable properties resulting from the use of ammonia alone.

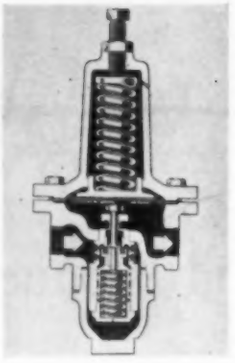
TANNOID is the name of a new first-aid tannic acid treatment for burns, recently introduced by the Davis Emergency Equipment Co., 55 Van Dam St., New York, N. Y. This material consists of a water soluble jelly containing the proper proportion of tannic acid which, applied to a burn, is claimed to relieve the pain, lessen the toxic effect and reduce the formation of scar tissue.

SUBSTITUTES for carnauba, ozokerite and Japan waxes, which are made from domestic raw materials and are available at low prices, have been announced by the Glyco Products Co., 148 Lafayette St., New York, N. Y. Acrawax, the carnauba substitute, has a melting point of 95-97 deg. C., Ozowax, the ozokerite substitute, has a melting point of 76-85 deg. C. Nipocer, the Japan wax substitute, melts at 46-49 deg. C. These materials are soluble in the usual organic solvents.

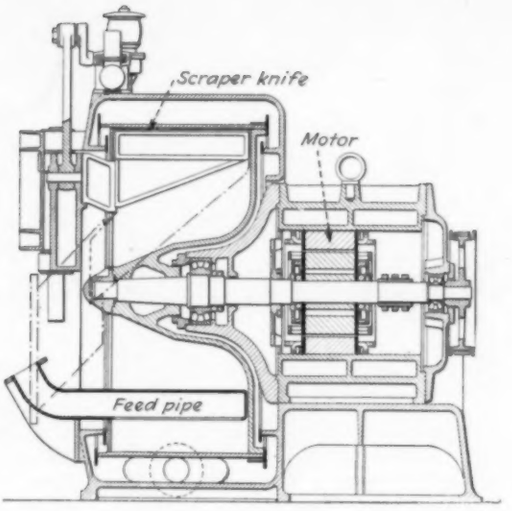
A PRODUCT developed on the Pacific Coast and recently introduced into the East, is an industrial protective cream produced by H. W. Stover Co., 1013 Madison St., Oakland, Calif. This material is used in the protection of the hands and other exposed skin against industrial dermatitis. It is being used in such fields as the petroleum industry, the manufacture of paint, varnish and lacquer products, in handling solvents and in the manufacture of numerous chemicals, according to the manufacturer. The cream is available in ¼, ½ and 1 lb. jars and is insoluble in water except when soap is used.

PREVIOUSLY SOLD only under license agreement, the B. F. Goodrich Co., Akron, Ohio, has now released its line of Vulcalock cements for sale on a restricted basis. These cements, which are used in making joints between rubber and metals, are also claimed to be of service in joining a wide variety of other materials including many synthetic resins, woods and ceramics. These cements consist of solutions of Thermoprene, a patented thermoplastic made by the chemical alteration of rubber. Bond strengths as high as 500 lb. per sq.in. can be obtained, according to the manufacturer.

This same company has also announced a new Koroseal paint designated as No. 495 Korolac, which gives a semi-glossy black finish and is recommended by the manufacturer for use wherever extremely corrosive conditions are met. A special primer is required. Resistance is claimed against all acids, alkalis and salts in commonly met concentrations at temperatures to 150 deg. F. Either brush or spray application is suitable for both primer and paint.



New reducing valve




**Right—Reineveld horizontal bulk centrifugal featuring main bearing at center of gravity of basket**

## Self-Contained Reducing Valve

AN IMPROVED self-contained reducing valve known as Type BB has been announced by the Fisher Governor Co., Marshalltown, Ia. The valve is designed for receiving a varying or high pressure of air, water, noncorrosive gas or oil at the inlet side and automatically delivering a constant reduced pressure to the outlet side. It employs a single-seated inner valve with special composition disk. For steam service, a stainless steel, bevel-seat inner valve is furnished. Either a laminated stainless steel or composition diaphragm can be used.

## Bulk Centrifugal

AN IMPROVED TYPE of centrifugal separator of the horizontal bulk type, available with both perforate and imperforate baskets, has been introduced into the United States from Holland by the Reineveld Corp., 20 Exchange Place, New York, N. Y. As is evident from the accompanying cross-sectional drawing, the outstanding new feature of this centrifugal is the location of the main bearing in the center of gravity of the revolving mass. This feature is said to eliminate vibration and permit higher speeds than with conventional designs. Furthermore, the absence of vibration and the rigidity of the shaft permit the motor to be built into the machine and thus reduce the floor space required. Available sizes range from 16 to 80 in. diameter of the basket. A speed of 900 r.p.m. may be employed for the larger machine mentioned, and 3,000 r.p.m. for the smaller.

Solids, as in the case of other horizontal bulk centrifugals, are discharged at full speed by means of a scraper knife. Automatic, semi-automatic or manual control may be employed. Another advantage claimed for the rigid construction is that rapid feeding may be employed without vibration due to surges. Since a full charge can be introduced at once, classification of the solids is said to take place, with coarser particles thrown to the wall, thus furnishing a desirable filter bed.

A considerable number of these machines are in operation in Europe. A 2,000 mm. machine operating on fine bicarbonate of soda produces 90 tons in 24 hours with a moisture content of 6 per cent. A 1,050 mm. machine operating on ammonium sulphate, at 95-100 deg. C., produces one ton per hour with 1.7 per cent moisture. This machine is inclosed to prevent escape of vapors. A 1,275 mm. machine operating on nitrocellulose produces 400 kg. per hr. with 30 per cent moisture. A 1,600 mm. machine operating on cornstarch has a capacity of 90 tons in 24 hours with a discharge moisture content of 32 per cent.

## Equipment Briefs

A RECENT DEVELOPMENT of the Breuer Electric Mfg. Co., 5100 North Ravenswood Ave., Chicago, Ill., is an attachment known as the Skrap-trap which is used in connection with the company's portable electric blower when the latter is being used for vacuum cleaning. This device collects small objects which are unavoidably drawn into the nozzle of the cleaner, thus preventing these objects from reaching and injuring the suction fan blades and making it possible to salvage such parts which would otherwise be lost with the dust.

NEW EQUIPMENT for counting and size estimation of dust particles has been announced by the Mine Safety Appliances Co., Pittsburgh, Pa. Known as the

M.S.A. Microprojector, the new instrument projects an image of a microscope field upon a ruled translucent screen, providing a magnification of 1,000 diameters for counting, and 10,000 diameters for particle size determination. The new method permits counting more concentrated dust samples without secondary dilution and is claimed to speed the counting, with less eye-strain than by microscopic counting.

A NEW intermetallic compound of tungsten-titanium carbide, manufactured by McKenna Metals Co., 209 Lloyd Ave., Latrobe, Pa., and sold under the name of Kennametal, is now being applied according to the manufacturer to difficult corrosion and abrasion resisting applications in pumps and valves. Tests are stated to indicate that valves made of this metal will far outlast valves of other materials.

FOR THE MEASUREMENT of air velocities in the range from 10 to 6,000 ft. per min., Julien P. Friez & Sons Div. of Bendix Aviation Corp., Baltimore, Md., has announced the new Thermo-Anemometer, an instrument suitable for use in air at temperatures of from zero to 120 deg. F. (or up to 300 deg. F. on special order). The instrument may be used in open air, in front of discharging ducts, or in ducts. It consists of a pair of thermometers, one of which is heated electrically. Owing to cooling of the heated thermometer, the difference in temperature betwen the two thermometers varies with the air velocity. Compensation is provided for variations in temperature, humidity, radiant heat and self-generated convectional currents. A small chart contained in the carrying case cover permits quick determination of the air velocity.

A MERCURY pressure gage or manometer for pressure measurements up to 3½ lb. gage has been introduced by the Connelly Iron Sponge & Governor Co., 3151 South California Ave., Chicago, Ill. The body of the gage is of cast semi-steel and the tube, which is threaded directly into the casting, is an unbreakable glass substitute. Compact design and wide-angle visibility are important features.

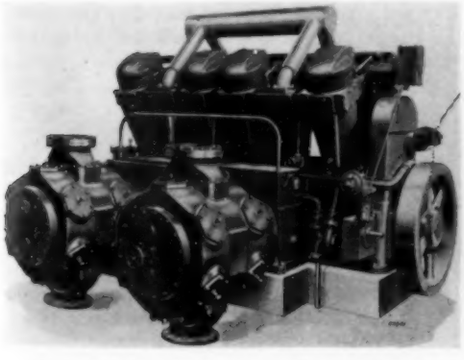
U. S. ELECTRICAL MOTORS, INC., Los Angeles, Calif., has announced a new lubrication system for motor bearings known as the Lubriflush system. The system makes specific provision for the escape of old lubricant when new lubricant is applied to the bearings. By this method, a duct leading from the outside of the motor conducts the new lubricant to the inner side of the bearing, and as the new lubricant is injected, the old lubricant is forced out of the bearing and through a drain exit.

## Housed Propeller Fan

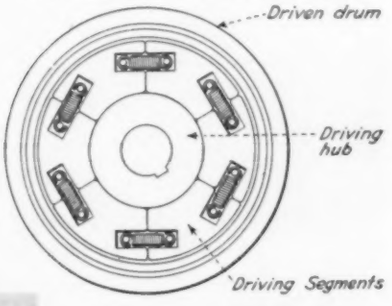
FOR INSTALLATION where the fan motor must be outside the air stream, such as in cases of excessive moisture, heat, dust or fumes, the Buffalo Forge Co., Buffalo, N. Y., has developed a housed propeller fan known as the "L" Breezo, which is made in sizes from 12 to 36 in. diam., for free delivery capacities from 1,080 to 10,800 c.f.m. The unit includes a square housing with the air inlet at top, bottom, or either side (and changeable on the job, if desired). In one side is the propeller fan and outside the opposite side is the motor, drive belt and one bearing carrying the fan shaft. The second bearing is within the casing and is generally of a type requiring lubrication not oftener than every 2,000 hours of use. Fans of this type are used in conjunction with hoods or spray booths and generally discharge into a duct, providing that the system resistance is not made higher than about ¼ in. w.g.

**Housed propeller fan**

**New gas-powered compressor**



**Cross-section of centrifugal clutch**




**Variable auto-transformer**

## Gas-Engine Compressor

DESIGNATED as Type LVG, a new heavy-duty gas-powered compressor, built in 485- and 650-hp. sizes, has been announced by Ingersoll-Rand Co., 11 Broadway, New York, N. Y. The new compressor is built in six- and eight-cylinder V-engine types and features simplified piping and the elimination of all but two stuffing boxes. Overhead valves, removable power cylinder liners and an auxiliary power take-off are other features. Pressures ranging from vacuum to 5,000 lb. may be handled.

## Automatic Centrifugal Clutch

FOR POWER DRIVES up to 125 hp. Dawes Equipment, Inc., 2280 Penobscot Bldg., Detroit, Mich., has introduced a new centrifugal clutch which is available in six standard sizes. This clutch is of the type which automatically disengages at low speeds of the driving machine. As the latter is accelerated, however, centrifugal action of the clutch causes a gradual engagement of the load, accelerating the latter in a uniform and shockless manner. Thus starting demand loads are reduced and wear decreased on driven equipment, according to the manufacturer. The clutch consists of two main parts, an expansion body or driving member and a housing drum or driven member. The expansion body consists of six metal segments interconnected by tension springs and operating on individual posts extending radially from a driving hub. The driven member contains a brake lining with which the metal segments make contact when sufficient centrifugal force is produced. Metal-to-metal wearing surfaces are eliminated and lubrication is not required.

## Variable Auto-Transformer

GENERAL RADIO CO., 30 State St., Cambridge, Mass., has announced the Type 50 Variac, a continuously variable autotransformer intended for control of industrial applications and available in a 115-volt model at 5 kva. and a 230-volt model at 7 kva. Suggested applications include line voltage control, control of heat in electric furnaces, and speed control of electric motors, such as those used on centrifugals. Both types can be connected to give output voltages 17½ per cent above line voltage: 0-135 volts for the 115-volt model, and 0-170 volts

for the 230-volt model. Two or more units can be ganged for polyphase operation.

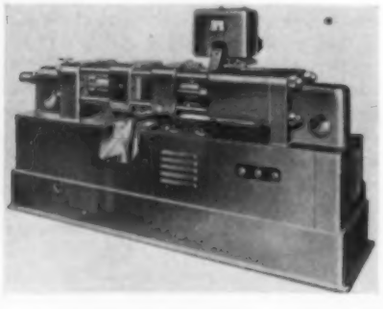
## Injection Molding Press

MODEL 40 H-2 is the designation of a new injection molding press of the self-contained horizontal clamp type recently announced by the Hydraulic Press Mfg. Co., Mt. Gilead, Ohio. The machine is equipped with both manual and automatic controls. The closing of the clamp, injection stroke and opening of the clamp are controlled by hand levers, with heat and motor operation control by push-button. Manual, semi-automatic or full automatic operation may be selected at the will of the operator.

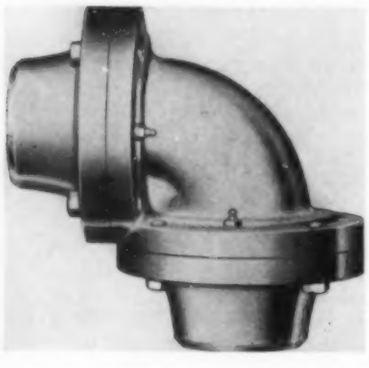
## High-Pressure Joint

A LINE of steel swing joints for high or low pressures, giving full 360 deg. rotation in one, two or three planes, has been announced by the H. and B. Sales Co., Long Beach, Calif. These joints are designed for use on liquids, gases and steam at pressures up to 5,000 lb. The higher pressure joints swivel on tapered roller bearings and are provided with fittings for easy lubrication. A special composition of packing, said to be resistant to acids and other materials, is provided to protect the bearings. The low-pressure joints are of drop-forged steel construction provided with a brass wearing ring instead of roller bearings. These joints may also be lubricated from the outside. In both types full-line diameter is provided and abrupt directional changes avoided. Such joints are intended particularly for liquid loading operations under pressure. Sizes range from 2 to 8 in. in the several types.

New injection molding press



Pressure swing joint



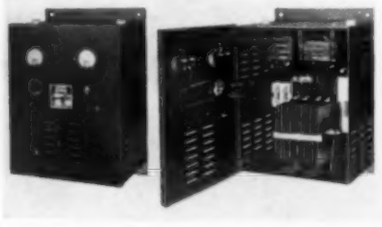
## Selenium Rectifier

FANSTEEL METALLURGICAL CORP., North Chicago, Ill., has announced a new line of industrial rectifiers known as Type SR. These rectifiers employ a new rectifying medium, selenium plates, which operate in a manner similar to other dry plate type rectifiers. However, a smaller number of plates of smaller size is required for a given voltage-current output. As efficiency is little affected by temperature, special cooling equipment is unnecessary. Overloads as high as 75 per cent for several hours can be handled without deterioration, according to the manufacturer. Both full and half-wave types are available for practically any desired d.c. voltage and current output. Suggested applications include current supply to magnetic clutches, solenoid valves, alarm signal and communication systems, and isolated d.c. motors. Standard equipment includes dial tap switches for control, fuses and d.c. voltmeter and ammeter.

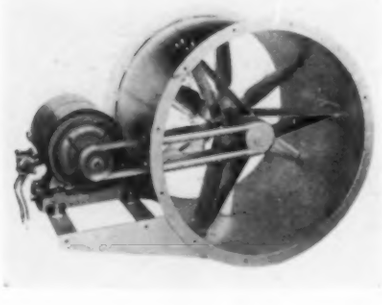
## Duct Fan

PRIMARILY designed for use in duct systems, a new fan unit has recently been announced by South Bend Air Products, Inc., South Bend, Ind. The new fan is claimed to have a number of advantages especially where corrosive gases are to be handled. Both single and tandem fan types are available. Static pressures as high as 3 in. are claimed. Capacities range upward to 26,000 c.f.m. in the single fan type and 30,000 c.f.m. in the tandem type. Multiple propeller-type blades of drop-forged aluminum alloy are used. The belt and all working parts are completely inclosed.

New industrial rectifier



New duct-mounted fan



## Respirator Cartridges

AMERICAN OPTICAL CO., Southbridge, Mass., announces the development of three new chemical cartridges which are quickly and easily interchangeable with the standard Type A dust cartridge now being supplied for this company's Type R1000 respirator. Thus this respirator may now be secured with a range of four protective filters, each claimed to provide highly efficient protection against Type A dusts or non-lethal concentrations of certain fumes and vapors. One of the new cartridges is employed for fumes and gases encountered in paint spraying, and other light organic vapors. Another is used for low concentrations of acid gases and the third for low concentrations of acid organic gases.

## New Developments

KOREZ, a new impervious synthetic resin cement, has been developed by the Atlas Mineral Products Co. of Pennsylvania, Mertztown, Pa. This material, applied as a mortar which quickly sets by chemical action at room temperature, is stated to yield a dense, strong joint which is impervious and inert to all acids except those which are highly oxidizing, and inert to oils, water and mild alkalis at temperatures to 330 deg. F. Being nonporous, this cement is said to be particularly adapted to the construction of acidproof brick-lined equipment for the recrystallization of salt solutions.

EXTENSIVE REVISION of the design of its Stearns-Wetherill Type R cross-belt magnetic separator has been announced by the Stearns Magnetic Mfg. Co., Milwaukee, Wis. Each individual magnet gap is separately adjustable by means of hand wheel control. The speed of the main conveyor belt and also the cross belts can instantly be increased or decreased through variable speed motors. A simple and practical means has been provided for slack take-up of all belts.

A NEW LINE of corrosion-resisting coatings has been introduced under the name of Co-Res-Co by the Corrosion Control Corporation, 212 Wright St., Newark, N. J. Three types, a black, an olive green and a special black for severe alkaline conditions are available. These materials are advocated by the manufacturer for the protection of steel and other metals, wood, brick and concrete, against atmospheric corrosion, salt air and water, dilute acids and fumes, and alkalis. Liquid temperatures to 150 deg. F. and dry heat to 600 deg. F. are said to be without damaging effect.

# Removal of Hydrogen Sulphide

SOUR NATURAL GAS, containing hydrogen sulphide, is useless for industrial and domestic fuel purposes. With many sweet gas fields slowly becoming depleted and others gradually turning sour, and with large supplies of sour gas available the problem of purifying such gas has during recent years attracted a great deal of attention. The principal difficulty was to provide complete purification at a cost low enough to enable the purified gas to compete with naturally sweet gas from more distant sources.

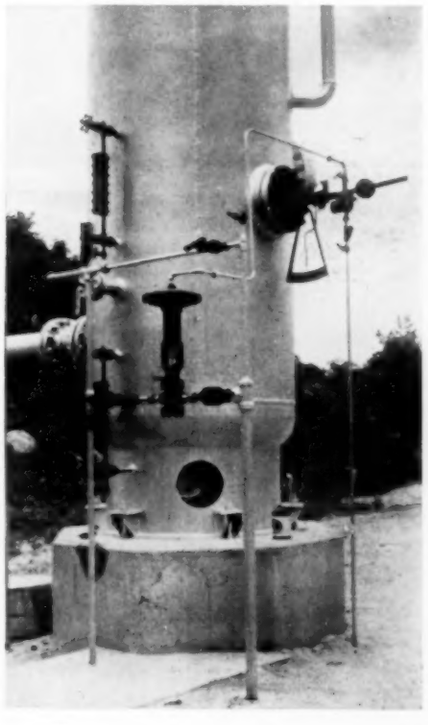
One of the processes, developed some ten years ago, which accomplishes this purpose is the Girbotol process of the Girdler Corp. This process is based on the fact that certain organic bases (aliphatic amines and amino alcohols) have at normal temperatures a strong affinity for hydrogen sulphide, an instantaneous absorption rate and very high total capacity, and that hydrogen sulphide is released by these bases at somewhat higher temperatures. These absorbents are restored to their original condition and completely reactivated without loss of effectiveness simply by heating to a few degrees above the boiling point of water. The bases are not affected by other gases present in the gaseous mixtures being treated. No undesirable side reactions take place and the bases are non-flammable, and non-corrosive to ferrous metals.

Another application of the Girbotol process is for the removal of hydrogen sulphide from refinery gases. Due to the recent development of catalytic processes such as the Houdry process this is of increasing importance.

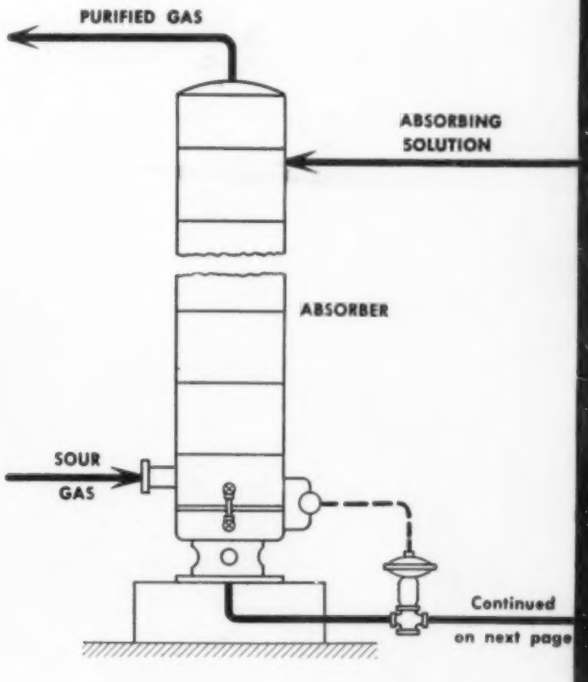
The process is also used for separating carbon dioxide from gas mixtures and is being applied commercially for scrubbing carbon dioxide from hydrogen produced by cracking methane. It is also widely used for the recovery of carbon dioxide from flue gases and other waste gases for the production of liquid and solid carbon dioxide.

The equipment, which is similar to that used in the natural gasoline absorption process, is shown in the accompanying flowsheet.

A Chem & Met PICTURED FLOW SHEET

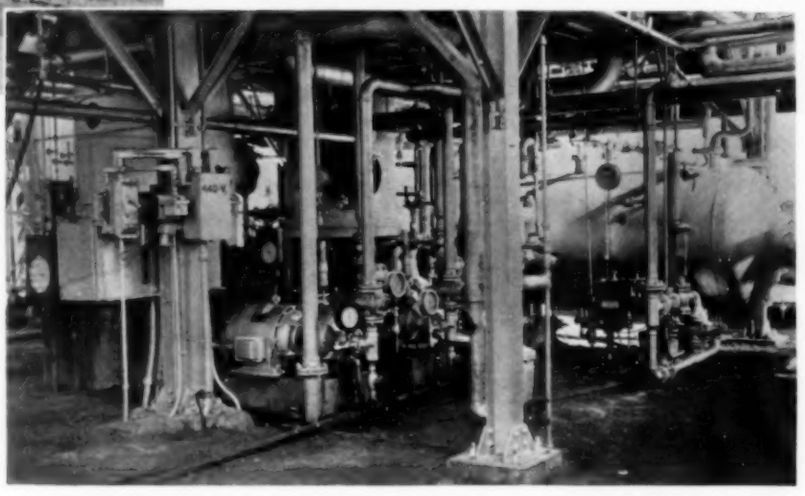


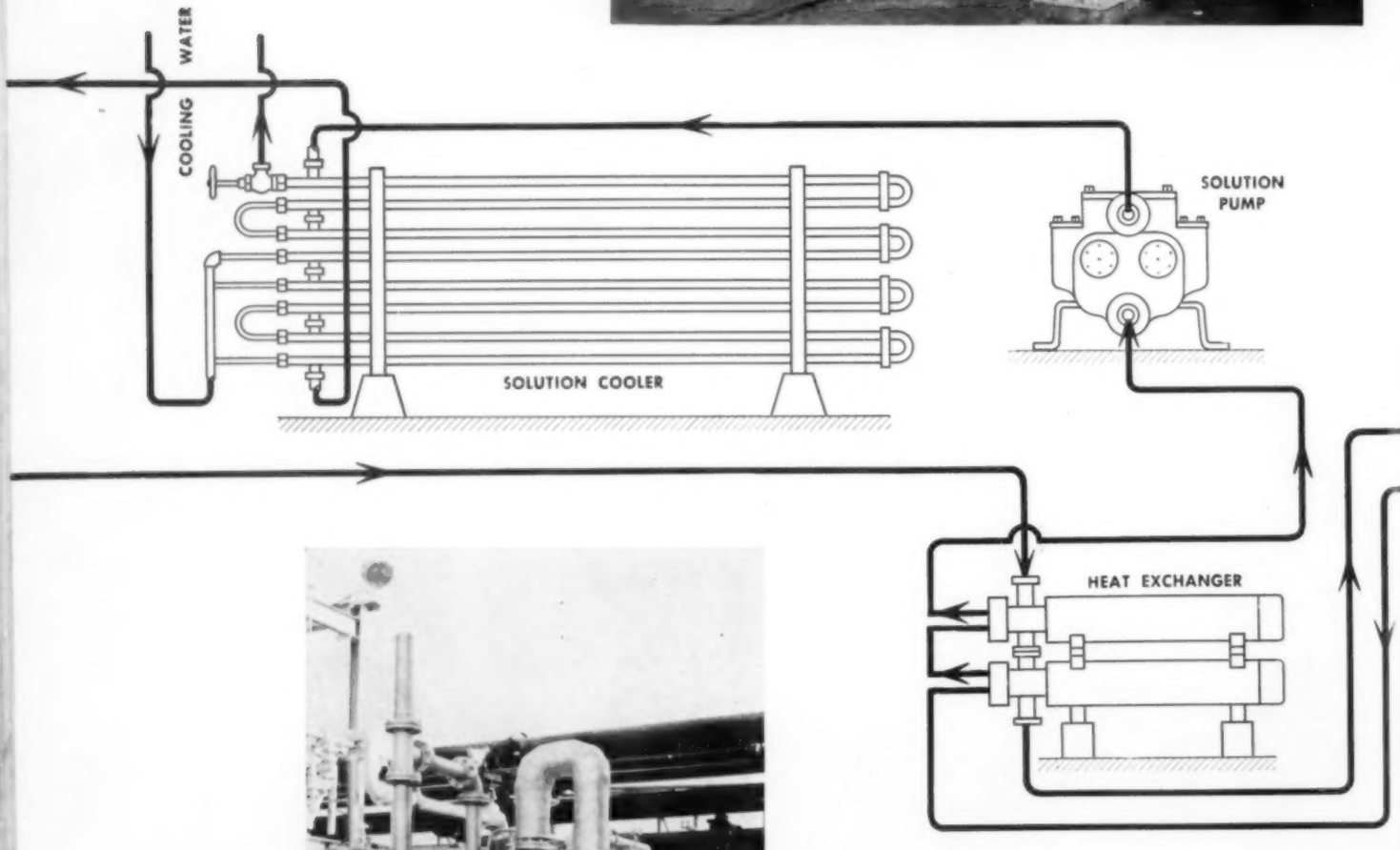
Natural gas at line pressure flows through a gasoline separator in the base of the absorber and into the tray section above, where it is purified. Scrubbing solution passes from the absorber through a liquid level control valve and flows by absorber pressure to the regenerating equipment

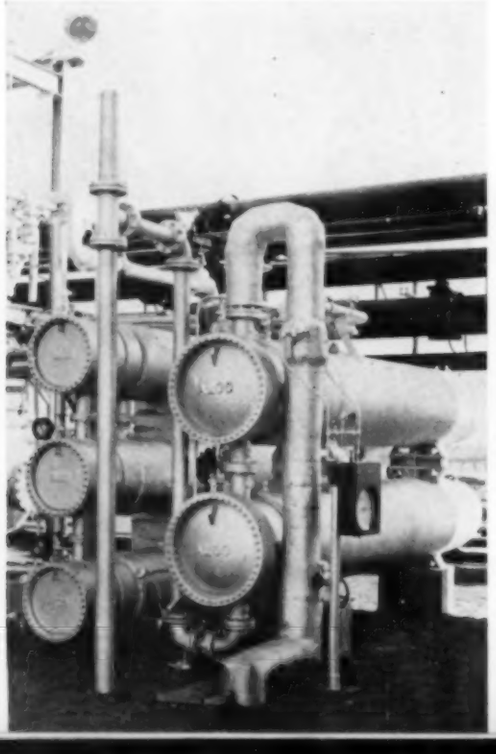


Heat exchangers and coolers, shown at the right, are used to bring solution streams to the proper temperatures for flow to absorber and reactivator. The steam heated reboiler at the base of the reactivator is shown on the platform at the left

Solution pumps in most refinery purification plants are driven with explosion proof motors. Welded piping is also preferred

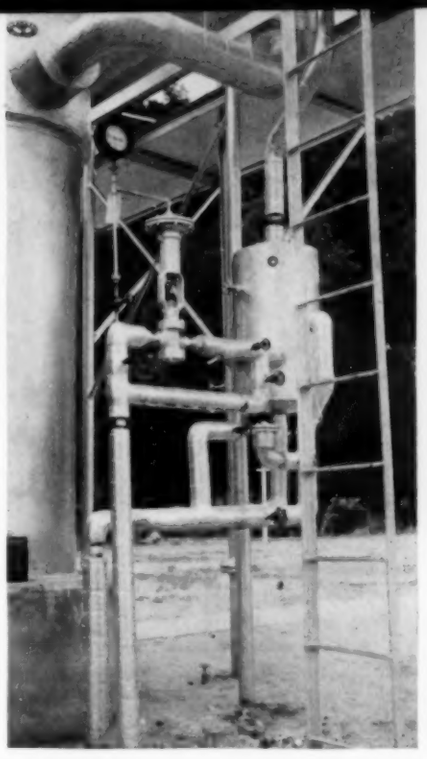




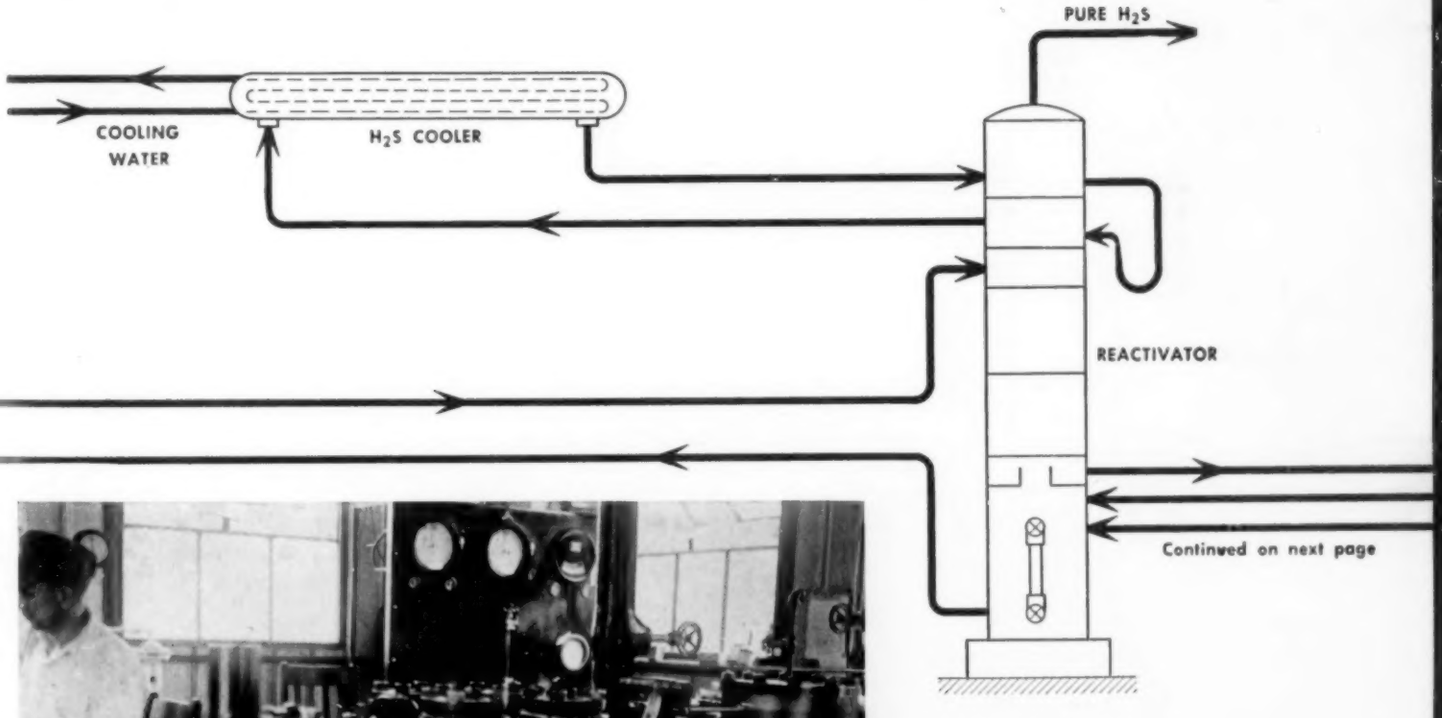



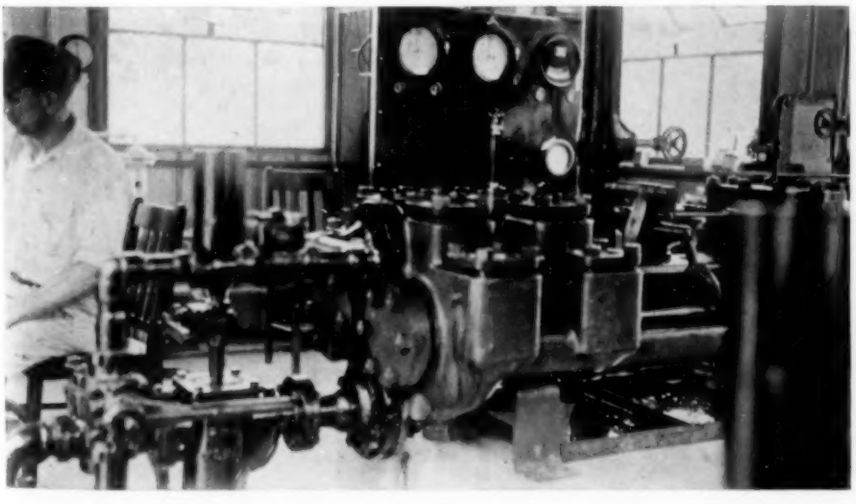
In the larger Girbotol plants, shell and tube type heat exchangers are used. For low solution rates, particularly in dehydration plants, double pipe, extended surface exchangers are employed

The steam pressure in the reboiler is automatically controlled to insure proper reactivation. A portion of the steam condensate from the reboiler flows as reflux from the accumulator shown here to the top of the reactivator to maintain the desired solution concentration



The Girbotol process purifies high sulphur refinery gas. Shown are absorber, reactivator, heat exchangers and reboiler. The solution pump is under the steel structure. The hydrogen sulphide cooler is mounted at the top of the reactivator so that condensate may return to the tower by gravity. When the gas is flowing at its dewpoint the absorber is insulated to prevent condensation of hydrocarbons

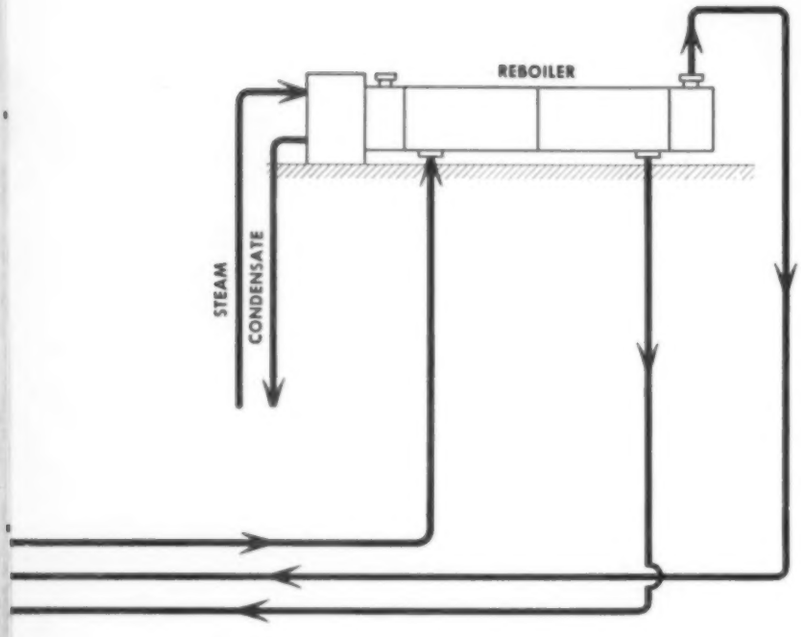


The pump house houses the lean solution pump and the instruments. Control tests are also made here

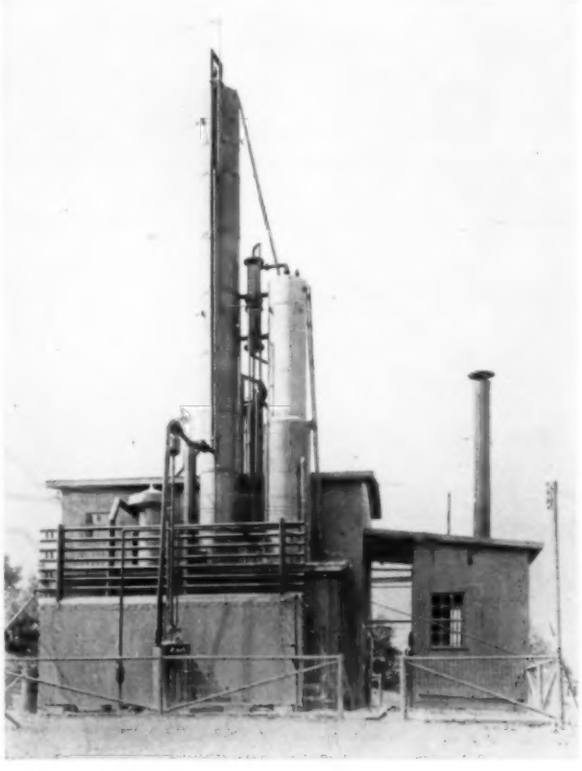
Several Girbotol plants purify small volumes of gas for engine fuel, and for camp heating in isolated areas. These are compact portable units. They represent economy over caustic soda scrubbing and there is no spent solution disposal problem

Large volumes of hydrogen are used for the manufacture of aviation gasoline and lubricating oil. The Girbotol process is employed for scrubbing carbon dioxide out of the raw hydrogen. The carbon dioxide content of the gas mixture is reduced from 18-20 per cent to 0-0.2 per cent in a single stage cycle




A Chem & Met PICTURED FLOW SHEET

The first plant for the purification of gas was built in 1930. In 1939 the total purification capacity is in excess of 250,000,000 cu. ft. per day



# Chemical Engineering NEWS

## Aluminum Co. of America Will Build Plant at Vancouver

Fulfillment of the forecast that new industry would move to vast new power sources in the Northwest came with announcement by Secretary of the Interior Harold L. Ickes that a 20-year contract had been signed between the Government and the Aluminum Co. of America for sale of a substantial block of Bonneville power.

The Aluminum Co. will establish a plant at Vancouver, Wash., costing several million dollars for the purification of aluminum ore and its reduction to metal by electrolysis. Other proposed contracts for the sale of Bonneville power to industry working with metals are under active negotiation. Bonneville Administrator Paul J. Raver notified Secretary Ickes that the initial sale for the 20-year period was for 32,500 kilowatts of power generated at the government-owned Bonneville Dam.

Administrator Raver advised Secretary Ickes that the delivery of power under this contract will begin as soon as the company completes construction of its plant. The works, which represent expansion of Aluminum Co. operations, heretofore confined to the East and South, will be located on the north branch of the Columbia River, just west of Vancouver and not far from Bonneville's largest substation. The new plant is expected to be completed on or before January 1, 1941.

Administrator Raver reported that the company will pay $17.50 a year for each kilowatt of power it purchases. It will take initial delivery of 27,000 kilowatts and will increase this demand at the rate of 500 kilowatts per month, until it is purchasing a total of 32,500 kilowatts. Further purchase will be under additional contracts.

## I.C.C. Grants Change in Freight Rates on Molasses

Permission has been given by the Interstate Commerce Commission to the Illinois Central, Missouri Pacific and other roads to make a rate of 15 cents per 100 lbs. on 1,800-ton shipments of blackstrap molasses from New Orleans to the plant of the Commercial Solvents Corp. at Peoria, Ill. The 1,800-ton minimum is equivalent to 38½ tank carloads and this is the first trainload rate to be made since the I.C.C. has had authority to regulate rates. The precedent is of high importance because shippers of oil, particularly the big independents, and other bulk commodities will seek immediately to take advantage of it.

In the past the Commission has opposed train-load rates on the ground that such preference would tend to concentrate business in the hands of large concerns contrary to the public interest. The I.C.C. has given the shipper of carlots a preference over the shipper of less-than-carload quantities but, heretofore, has invariably held that it is unjust discrimination, and hence unlawful, to give the shipper of trainload or multiple carload quantities any preference in rates over the shipper of single carloads.

Now, however, the Commission recognizes the fact that the shipper who can fill a boat or a barge or pump his product into a pipe line already has gained a decided advantage over the shipper of small quantities. Hence, the I.C.C. has finally come to the conclusion that the railroads should have the benefit of competing with the barge lines and pipe lines on more nearly equal terms. The Mississippi Valley roads can move molasses at a much lower cost per 100 lbs. in trainloads than in carloads.

Under their present carload rate of 17½ cents on blackstrap the roads hauled 144 carloads to Peoria as compared with the movement of 622 carloads by water in the first seven months of this year. According to the Commercial Solvents Corp., the cost of its own barge operations is 12 cents per 100 pounds and the towing rate quoted by the Federal Barge Line to the corporation is 14.5 cents per 100 pounds.

Since competing forms of transportation already afford advantages to large shippers the situation from the standpoint of public policy will not be changed in the opinion of a majority of the Commission, if the railroads by making rates on like shipments are able to obtain a larger share of the traffic.

## Leipzig and Brussels Trade Fairs Will Open in March

Following its regular schedule, the Leipzig Trade Fair will be held March 3-10, 1940. More than a score of countries will send their newest art and industrial products. The Technical Division of the Fair will as usual be the clearing house for every form of machinery. A new building has been added to the forty-two structures already in use, making available over 4,000,000 square feet of exhibition space. The Spring Fair will be the 1983d session of the historic exchange which has been held without interruption for more than 700 years.

The Brussels International Industries Fair, which was started after the World War also will be held in March. A Belgian Review of International Trade, published in Dutch, English, French, German, Italian, Portugese and Spanish, containing an illustrated description of the premises, stands, goods with all technical details, together with the names and addresses of firms who will have displays in the eleven halls, has been prepared and will be sent free to interested parties.

## New York University to Give Courses in Radiography

Because of the increasing importance of X-ray procedures in testing materials in various branches of industry and art, New York University has scheduled three courses in industrial radiography as part of the science program of its Division of General Education, it is announced by Dean Ned H. Dearborn. Believed to be the first offerings of its kind in any university in this country, the new courses will begin February 1. Herbert R. Isenburger, president of the St. John X-Ray Services will be in charge.

Designed primarily for engineers and others whose work involves the scientific testing of materials, the new courses will include both a series of fifteen evening lectures and an opportunity for those who desire laboratory work to familiarize themselves with actual practice in an industrial X-ray laboratory. In order to accommodate engineers from out of town provisions have been made to enable the laboratory work to be taken in thirty hours on five consecutive days.

## Southern Kraft Corp. Increases Plant Capacities

Southern Kraft Corp., a subsidiary of International Paper & Power Co., is adding to the capacities of its plants at Georgetown, S. C., and Springhill, La. The additional capacity will be in operation by the first of next April and will give the corporation a container board output of more than 1,000,000 tons compared with production of about 510,000 tons in 1939. Domestic production of paperboard ran at record levels in the latter part of last year.

TRAIN-LOAD RATES on molasses from Louisiana to Illinois were recognized as desirable by an Interstate Commerce Commission decision, released on December 15. Permission was granted for filing a rate of 15 cents per 100 pounds on 1,800 ton shipments of blackstrap in this precedent-breaking decision. The old rate by rail was 17.5 cents for carloads; no train-load rates were previously recognized.

In making its decision the Commission was clearly seeking only to give the railroads a chance to get this business away from the water carriers whose costs were stated to be in some cases as low as 12 cents per 100 pounds. But the Commission decided that a 14 cent rail rate was too low, apparently believing that it was unnecessary to go as low as that in order for the railroads to reclaim a substantial share of this transportation business.

Other industrial commodity shippers who might be benefited by train-load rates on their raw materials or products are expected to press the Commission for comparable rates on their goods. Petroleum, gasoline, and other oil products are expected to be among the leaders seeking such new rate structure. But it is evident that acceptance of this system by the I.C.C. may be limited to those who can illustrate that water or pipeline competition makes low rail rates necessary for competitive reasons. No general adoption of train-load rates is to be expected.

### Industry By Dictum

Some proponents of new industry in the far west persuaded the President that there ought to be a steel industry on the Pacific Coast. The President so announced at one of his newspaper conferences, reminding the press that he had long had as a hobby the idea that such development should occur. Those in Washington undertaking to dig under the surface failed to uncover anything more than a hope to substantiate this announcement. There has, therefore, been much chuckling that the real news on new western industry related to aluminum, not to steel.

During the holiday week the Bonneville Authority announced in Washington the closing of a twenty-year power contract between the government and Aluminum Co. of America. A large block of electrical energy is to be supplied from this new hydroelectric plant for a complete new western aluminum plant. Manufacture of alumina from bauxite, reduction of metal by electrolysis, and further fabrication are all planned. The initial contract provides for purchase up to 32,500 kilowatts, at $17.50 per kilowatt year, according to Secretary Ickes' announcement.

Washington rumor has it that a second power contract is to be announced before long for the Bonneville enterprise. It will relate to supply of electric energy for manufacture of sodium chlorate to be used as weed killer. Other electro-chemical industry is also hoped for, and expected. Presumably it will be on a basis much more substantial than the official steel dreams, which are inspired mainly by hopes of public-ownership propagandists.

## NEWS FROM WASHINGTON

**Washington News Bureau**
**McGraw-Hill Publishing Co.**
**Paul Wooton, Chief**

### Twin Patent Inquiries

The Department of Justice announced two distinct further efforts to determine the legal limitation that may be imposed on patents. Because these were simultaneously announced, much of the publicity given has confused the two separate undertakings. They are quite distinct, even in purpose. They are:

1. A civil equity suit has been brought in the Federal District Court at Toledo against 12 corporations and more than 100 individuals engaged in some part of the glass container and glass machinery business. Criminal proceeding was not possible because those involved in this litigation had previously testified before T.N.E.C. during a very early part of its Washington hearings.

By this suit the Justice Department undertakes to stop certain restrictive monopolistic practices which are charged against the companies and their officers. The Department hopes that it may prevent further use of agreements between companies regarding allocation of markets, customers, or quantities of goods produced. The Department points out that the Supreme Court has recently ruled in other cases that a legal right such as a patent may not be used for an illegal objective. They believe that the patents involved in this case are being so used, and seek to have a clear court definition by which similar business practices of manufacturing enterprise may be regulated under the anti-monopoly statutes.

2. A grand jury proceeding was initiated in New York by the Department of Justice as a general investigation. The purpose is to determine present practices in the use of patents, patent-pooling agreements, and patent-licensing contracts. Thus the investigative feature is quite as important as the punitive feature. Nevertheless, the Department expects to have the jury return a significant number of indictments of those industry units and individuals who are found to be indulging in practices prohibited under the anti-trust laws.

The New York case combines the new Thurman Arnold technic of investigation by grand jury with the customary disciplinary procedure which, hitherto has always dominated in such federal court cases. The ultimate result is likely to be a further definition of the limits on joint use of patents required by the anti-trust statutes, as well as some criminal prosecutions.

### Sugar Plays "Finnegan"

Last September the President eliminated import sugar quotas to limit speculative price increases. The day after Christmas these quotas were "on again". And the President, in restoring the quota system for control of total domestic sugar supply, warned that he might remove the quotas still another time if price or supply conditions warranted.

This changing of quotas illustrates a technic which the Administration would like to be able to use on all sorts of commodities, especially those important to agriculture or essential for the national market basket. As yet there is no legislative basis for comparable action on anything but the agricultural raw materials. This does not mean that New Dealers would not like similar authority on other goods. In fact, it can safely be inferred that they do hope to have in the hands of the Chief Executive a right to control quantities, and thus indirectly to control prices, of many essential goods.

If there is any attempt in this Congress to provide the President with more emergency power, this will be one of the principal methods to be expected in such a law. Enactment of such legislation during the present session of Congress is, however, not at all likely. In fact, Congress does not seem inclined to give the Administration any new emergency authority until a more real or imminent emergency appears above the legislative horizon.

### News "Fines"

Regional Labs Move—The senior staff of the four Regional Research Laboratories of the Department of Agriculture have moved from Washington to their new field stations. Correspondence and conferences will continue from those localities during the remainder of the time that the laboratory buildings are under construction. Actual experimental work in the new laboratories is expected to begin late next Summer.

Moral Embargo—Restriction on exports to certain belligerent nations is being exercised by the Administration through requests to interested industry. Producers of aluminum, molybdenum, aviation gasoline, and a few other important products of chemical-process industry are being so restricted. Although the President and the State Department have no legal authority to compel observance, the cooperation of interested industry seems assured. The restrictions are aimed particularly at Russia and Japan, which are defined as those nations which are indiscriminately bombing civilian areas.

Several western Senators and the State

Department are collaborating in an effort to formulate new legislation which might absolutely prevent certain types of export movement from the United States to Japan. Washington believes in "a double standard" of neutrality, one for our friends and another for the folks we don't like so well. But drastic legislation to this effect does not seem very likely. Embargo on goods movement to Germany is restricted by actual legislative requirements under the Neutrality Act.

Treated Textiles—New methods for testing and rating of the water repellent character of textiles have been developed and recommended by the National Bureau of Standards. One of the more recent important applications is in the proposed commercial standards for tents, tarpaulins, and covers in which the new methods are described. Recommended wording for certification for the waterproof characteristic of these products is also included.

Two Power Policies—The ideas of Secretary of Interior Ickes and of the Chamber of Commerce of the United States met with a resounding crash when the two Washington agencies announced during December their theories as to the future supply of power for emergency periods. The Chamber of Commerce argues in a statistical report that the power capacity of the nation is adequate to meet national needs even in a period of military activity. The Interior Department is urging that new systems of publicly owned transmission lines be established for interconnection of large power projects. It does not appear that Congress is in the mood to give money for this tremendously expensive supplemental power-handling facility. But promotion of these ideas is still believed to be "good politics" by official Washington. More will be heard of it even though little actual construction is likely unless the New Deal continues another four years in power.

Tariff Rates Change—Official promulgation was given late in December to the new tariff rates and quotas which apply to certain goods imported from the Philippines. Beginning January 1 some of these commodities are subject to full rates of duty when imported above quotas, which will be changed progressively from year to year from this time until July, 1946, when the Philippine independence law takes full effect. Restriction on the import of coconut oil free of duty is the most important item on this list for chemical-process industry.

Price Control—Proposal that the government take over price controls both in anticipation of military emergency and to prevent undue price rigidity got a serious setback during December. Assistant Attorney General Thurman Arnold frankly stated that he did not believe legislation to attack these problems was either necessary or practical. Instead, he urges a greatly enlarged staff which would be available throughout the country to investigate consumers' complaints regarding unwarranted price increases. He proposed also to use the grand jury proceeding for investigation of prices, as he is using it for patent investigations.

Fertilizer Organization—All of the fertilizer division of the Bureau of Agricultural Chemistry and Engineering was transferred during December to the Bureau of Plant Industry. This includes the work located at the Arlington, Va., station and the laboratory at American University in Washington, D. C. In its new bureau connection the work will be more closely interlocked with the studies on soil chemistry and physics, agronomy, and the field tests of fertilizer.

## Food Technologists To Hold Symposium in Chicago

First meeting of the Institute of Food Technologists is to be held June 17 to 19 at the Morrison Hotel, Chicago. Registration will start Sunday afternoon June 16 to be completed Monday morning before the first of the technical sessions starts.

Program will consist of four three-hour sessions devoted to symposiums on food engineering and on influence of processing on vitamin content of food supplemented by voluntary and solicited papers on food preservation, composition of foods, methods of analysis of foods, and packaging of foods. The third day is to be given over to visiting plants characteristic of Chicago's food manufacturing industry.

Plans for staging the meeting are being worked out by the newly organized Chicago Association of Food Technologists headed by Dr. E. H. Harvey, Wilson & Company, chairman of the local arrangements committee.

The Institute of Food Technologists was organized in Cambridge, Mass., last July at the close of the Second Conference on Food Technology held under the auspices of the Massachusetts Institute of Technology.

## Proposed Revision in Package Sizes for Insecticides

The Standing Committee in charge of Simplified Practice Recommendation R41-38, Package Sizes for Insecticides and Fungicides, has approved a second revision of the recommendation to include standard size packages for nicotine sulphate, also a one-pound bag for lead arsenate, calcium arsenite, and bordeaux mixture, and the Division of Simplified Practice of the National Bureau of Standards has submitted the proposed revision to the industry for approval.

This recommendation, which originally became effective May 1, 1926, established a simplified schedule of standard package sizes for certain agricultural insecticides and fungicides. The first revision, effective June 15, 1938, amplified the original recommendation to include standard package sizes for basic lead arsenate.

The revision now proposed not only includes a list of recommended standard types and sizes of packages but the number of packages per shipping case and the territory for which each package is considered standard.

## Dr. Finch Resigns from U. S. Bureau of Mines

Resignation of Dr. John W. Finch as director of the Bureau of Mines appears to be the first item of reorganization of that institution planned by Secretary of Interior Ickes. Only time can disclose the dominant purpose and plan, but it is evident that some of the changes contemplated are being made in an effort to make more aggressive the reform and regulatory efforts of this Bureau.

The more conservative career officials of this and other technical bureaus in the Department have long been known to oppose the intermingling of regulatory and research functions. Their argument is that if there is to be regulatory work done, it should be carried out by other agencies, whether in the Department or otherwise, so that the opportunity for active cooperation in scientific research and engineering development will not be jeopardized by the police function which any regulatory agency necessarily assumes.

Among the regulatory activities which have been proposed in connection with the industries for which the Bureau of Mines does research are the petroleum industry, the coal industry, and numerous of the strategic mineral industries. Legislation along these various lines has been proposed for consideration of the present session of Congress, but Washington has not thought that any very radical bills were likely to be enacted so late in the present administration.

## DuPont To Award Fellowships For Chemical Research

E. I. du Pont de Nemours & Co. has announced that it will award six post-doctorate fellowships for research in organic chemistry, and twenty post-graduate fellowships for research in the field of chemistry for the academic year 1940–41. An increase of two post-graduate awards is provided for the coming academic year. The post-doctorate fellowships are for $2,000 each, and the post-graduate fellowships are for $750 each.

Fellowships in advanced work in chemistry were established by the du Pont Company in 1918. The fellowships are not restricted to subjects connected with the Company's products, but may be in any chemical research deemed appropriate by the university. The university also selects the beneficiary.

The purpose of the du Pont Fellowship Plan is to promote the advancement of science and to cooperate with the educational institutions in their efforts to carry on advanced research work.

The institutions to which awards will be made include the following universities: California, Chicago, Columbia, Cornell, Harvard, Illinois, Johns Hopkins, Michigan, Minnesota, Northwestern, Ohio State, Pennsylvania, Princeton, Purdue, Stanford, Virginia, Wisconsin, and Yale. Pennsylvania State College and Massachusetts Institute of Technology also are named.

# JAPANESE RAYON AND TEXTILE INDUSTRIES SUFFER FROM LACK OF CELLULOSE PULP AND DYES

Special Correspondence

TAKING the annual average of chemical production for 1931–33 as 100, *Toyo Keizai Shimpo* calculates that the index reached its peak at 241 in June, 1939, but rather suddenly dropped to 217 in July. This indicates a genuine decline in production since the index is adjusted for normal seasonal fluctuations. The index of mining activity, which has a close bearing on chemical industrial production, reached its peak in December, 1938, when it stood at 169, but it has since dropped to 162. The index of chemical production is based on six industrial chemicals, weighted from 1 to 6 according to their importance.

The Nissan Chemical Industrial Co., a 124-million-yen concern with head-offices in Tokyo, has reportedly succeeded in developing a process for the manufacture of acetate silk after years of laboratory research. The fiber is produced from linters like other acetate silk, but is claimed to possess many characteristics of wool. Production cost is about 50 per cent higher than for viscose rayon. The company apparently has no immediate intention to industrialize the process. Japan's rayon industry to date has been concerned mainly with viscose fibers, cuprammonium silk being produced only by the Asahi Bemberg Co., a subsidiary of the German concern.

With domestic production of cellulose pulp still vastly inadequate and imports more difficult as a result of the European war, Japan's rayon and staple fiber industry finds itself in a tough spot and has little hope left that the early-September dreams of huge trade gains in Africa and Latin America will materialize in the near future.

The domestic supply of pulp for 1940 is expected to increase slightly, but there is no prospect that the "goals" set by the Tokyo planners will be reached. This applies, in particular, to Manchukuo pulp production schemes. According to a five-year schedule laid down some years ago, Manchukuo ought to be able to supply 60,000 tons of pulp in 1940, but owing to restricted supply of coal and other raw materials, the monthly production of each of the four concerns operating in Manchuria is not expected to exceed 800 to 900 tons a month, so that shipments will probably amount to not more than 35,000 tons.

In Korea, annual output amounts to 30,000 tons, of which 10,000 tons are consumed within the colony, leaving 20,000 tons for Japan proper.

The total pulp supply from within the "yen-bloc" will thus be something like 55,000 tons, about the same as last year. Reliance on imported pulp will therefore persist. Japan imported 330,000 tons in 1936, 480,000 tons in 1937 and 120,000 tons in 1938, exclusive of imports from colonies and Manchukuo.

Imports for the first ten months this year totaled 133,000 tons, of which Manchukuo supplied approximately 42,000 tons. Continuity of supplies from three important European sources, namely, Sweden, Norway and Finland, is now highly doubtful. During the first ten months this year, Japan imported 11,000 tons from Sweden, 26,000 tons from Norway and 12,500 tons from Finland, a total of 49,500 tons, or 54 per cent of all imports from outside the yen area.

The Tsinan plant of the New Central China Explosives Co., a subsidiary of the Japan Explosives Co. is scheduled to commence operation towards the end of 1939. The plant was formerly operated as an arsenal by the Shantung provincial government and assigned to the Japanese explosives firm after the Japanese army had taken control of the province.

With trade returns for the first two war months (September and October) now complete, it is possible to make a factual analysis of the effects of the European war on Japan's foreign trade in chemicals.

Though not strictly a chemical, but listed as such by the Japanese Department of Finance, hops was the item which was most severly affected on the import side. Up to the outbreak of the war, 97 per cent of Japan's imports were provided by Germany, and Japan's annual consumption is so large that a readjustment obviously meets difficulties; imports for October were down to zero.

Imports of citric acid for October were valued ¥79, compared with a monthly average of ¥3,215 for the preceding 9 months. There were no imports of borate of soda in October, although the previous monthly average was ¥13,215. Imports of chloride of potash were halved to 3,528 tons, from the previous monthly average of 7,016 tons. Imports of sulphate of potash for October were returned at 6,774 tons, vs. 8,854 tons for the preceding months. Imports of ammonium sulphate, monopolized by Germany, were nil in October, vs. 88,544 tons imported during the first nine months. Imports of nickel sulphate were also nil, though for no obvious reason since Great Britain and the United States are in this business; previously the monthly average was 8,400 tons. Imports of textile colors, also a German trade prerogative, were returned at ¥43,000 in October, compared with a monthly average of 350,000 yen prior to the outbreak of the European war. There were no imports at all in October of sulphide colors, vat colors and oil soluble colors. Many Japanese dye works have been compelled to shut down or curtail operations because there are no stocks to keep them going until new sources of supply are opened up. The recent monthly import average of 350,000 yen was already insufficient to meet requirements, the normal import demand, as reflected by the trade returns for 1937, is about 1,500,000 yen a month to pay for 20,000 tons.

On the export side, three distinct trends may be distinguished. (1) Japan's desire to conserve her scant supplies of certain raw materials which are now difficult to obtain because similar restrictions have been enforced in belligerent and neutral countries; (2) Curtailment of exports to the yen trading area in order to improve international accounts; and (3) exports of war materials to belligerents. If the net result was an increase in chemical exports for October to 11,697,000 yen, compared with a monthly average of 8,366,000 yen for the January-October period, this was less due to the weight of munitions exports than to the depreciation of the external value of the Japanese currency shortly after the outbreak of the war. One of the munitions items was sulphur, exports of which soared to ¥678,000 in October, from a monthly average of ¥241,000 prior to the outbreak of the war. Exports of sulphuric acid were boosted 50 per cent, and shipments of copper sulphate 250 per cent. Owing to elimination of Germany's synthetic camphor from most consuming markets, Japan's natural camphor was able to stage a spectacular come-back in October, exports for the month amounting to ¥1,023,000, compared with a pre-war monthly average of ¥400,000, with quotations unchanged. Almost identical figures, under almost identical circumstances, were returned for natural menthol crystal, exports of which in October amounted to ¥1,010,000, vs. ¥400,000 for each of the preceding nine months.

If present Japanese plans pan out, China may become again a producer of natural camphor as in olden days prior to the opening of Japan to foreign trade, when China and Borneo were the only producers of camphor for the world market.

The projected camphor plantation enterprise is to be under the management of the Formosan Government-General and the Japanese Ministry of Finance, which operates the Japanese camphor monopoly. The necessary preparations are scheduled to be completed by the end of this year.

It may be recalled in this connection that Japanese and Formosan natural camphor is already hard up against the competition of synthetic camphor, and the Monopoly Bureau has been experimenting for several years with synthetic processes. Unless production cost in China should prove to be very much lower than in Japan and Formosa, the Japanese project can serve only to saddle China with an industry that will be a burden rather than a commercial proposition, unless Japan abandons natural camphor altogether. Reports from Formosa indicate that the Government-General is likely to permit the felling of young trees to help increase production in view of the current brisk demand from abroad.

## Dr. Evans Elected President of A.C.S.

Dr. William Lloyd Evans, head of the department of chemistry of Ohio State University, has been elected president of the American Chemical Society for 1941. Professor Evans will take office as president-elect on January 1, 1940, at which time Dr. Samuel Colville Lind, dean of the Institute of Technology of the University of Minnesota, becomes president, succeeding Professor Charles A. Kraus of Brown University.

Three directors and four councilors-at-large were also elected, as follows:

Directors—Dr. Elmer K. Bolton, chemical director of E. I. du Pont de Nemours and Co., Wilmington, Del., Director-at-large; Leason H. Adams, director of the Geophysical Laboratory of the Carnegie Institution, Washington, D.C.; Dr. Robert E. Swain, head of the department of chemistry at Stanford University.

Councilors-at-large—Dr. Per K. Frolich, director of the chemical laboratories of the Standard Oil Development Co., Elizabeth, N. J.; Dr. Edward Mack, Jr., of the Battelle Memorial Institute, Columbus, Ohio; Dr. C. E. K. Mees, vice-president in charge of research and development of the Eastman Kodak Co.; Professor William A. Noyes, Jr., of the University of Rochester, Rochester, N. Y.

Professor Evans, who received the William H. Nichols Medal of the New York Section of the Society in 1929 for his work on the chemistry of carbohydrates, has been a member of the faculty of Ohio State University for thirty-five years, and chairman of the chemistry department since 1928. During the World War he was head of the laboratory and inspection division at the Edgewood, Md., Arsenal, and Major in the Chemical Warfare Service.

## Louisiana Engineers Hold Meeting in New Orleans

The annual meeting of the Louisiana Engineering Society was held at the St. Charles Hotel, New Orleans, on January 12–13. Following registration on the morning of January 12, conferences were held by members of student chapters at Tulane University and Louisiana State University. The annual business meeting was held and new officers installed. In the afternoon plant visits were made to International Harvester Co.'s twine mills and to the Chase Bag Co. A boat trip also had been arranged for inspection of the port facilities of New Orleans. In the evening, George W. Wheelwright of the Polaroid Corp., Boston, read a paper on "Polaroid—Its Applications".

In the morning session on January 13, Addresses were delivered on "Concrete—New Applications in Piling and Architectural Design" by A. J. Boase of the Portland Cement Association; "Furnace Design for Burning Liquid, Gaseous and Pulverized Fuels" by Otto de Lorenzi of the Combustion Engineering Co.; "The Wax Lake Outlet and the Charenton Drainage and Navigation Canal" by Lt. Col. William F. Tompkins, 2nd. U. S. District Corps of Engineers; and "Characteristics and Design of Gas Air Conditioning Systems" by George Elmer May. In the afternoon Harold A. Levey spoke on "Production of Modern Plastic Products".

## Welding Research Program Outlined for 1940

A $110,000 program of welding research will be carried out in 1940 by the Welding Research Committee of the Engineering Foundation, research organization of the national engineering societies.

More than seventy individual projects now in progress in universities and research laboratories throughout the nation will be continued, according to William Spraragen, technical secretary of the committee, which coordinates the research in cooperation with leading scientists in the field.

Studies in the weldability of steels, weld stresses, structural welding, and progressive failure in steels under repeated stresses will be emphasized. Research sponsored by the committee, Mr. Spraragen pointed out, aims to assist the steel industry by creating new markets for the use of steel.

## Colorimetric Method for Determining Arsenic

The Department of Commerce has announced that the National Bureau of Standards has developed a colorimetric method for determining arsenic. The method, which is reasonably rapid, was developed by Clement J. Rodden of the Chemistry Division, and will determine amounts of arsenic as small as two micrograms. It is applicable to determinations of arsenic in iron, steel, copper-base alloys, tin and lead base bearing metals, and pig lead.

The arsenic is first separated from other constituents by distilling as arsenic trichloride. It is then converted to a blue arsenic-molybdenum compound, and the amount of arsenic is obtained from transmittancy measurements, using either a photoelectric or an ordinary visual colorimeter. If the latter is used, the color is matched against standards.

## Air Conditioning Exposition Will Be Held in Cleveland

The Sixth International Heating and Ventilating Exposition will open at Lakeside Hall, Cleveland, on January 22, with exhibits of equipment by more than 300 leading manufacturers. The Exposition was held in Cleveland in 1932 and its other biennial appearances have included Philadelphia, Chicago, and New York.

Combustion and heating will be well represented by fuels, stokers, furnaces, oil burners, gas burners, boiler burner units and furnace burner units. Domestic, commercial, and industrial oil burners will be displayed, also central heating systems.

Other items on display will include gas heating as applied to paint drying, ink drying, and metal and food processing; a new built-in feature in air conditioning systems—a method for the separate removal of smoke; a new conversion burner offering exceptional flexibility and application range. An exhaust blower is designed for use with a unit heater. The arrangement makes it possible to install the unit where no flue is available. Fumes from a 200,000 B.T.U. per hour heater may be forced in any direction out a three-inch pipe.

Hundreds of instruments of precision and automatic controls will be on display, frequently in conjunction with apparatus, whose functions they record or govern. Instruments of precision will indicate and record and control such functions as pressure, volume, temperature, humidity, flow, and liquid level.

## Kansas State Plans Chemical Engineering Department

Beginning in February, a new department of chemical engineering will be established in the division of engineering and architecture at Kansas State College, Manhattan, Kans. Chemical engineering instruction and research previously have been handled in the department of chemistry. W. L. Faith will head the new department in the capacity of professor of chemical engineering. He will be aided by J. W. Greene as assistant professor and by J. E. Hedrick as instructor.

## CALENDAR

**JAN. 22-26, 1940, International Heating & Ventilation Exposition, Cleveland, Ohio.**

**FEB. 19-22, 1940, Technical Association of the Pulp & Paper Industry, annual meeting, Hotel Roosevelt, New York, N. Y.**

**APRIL, 8-12, 1940, American Chemical Society, annual meeting, Cincinnati, Ohio.**

**APRIL 24-27, 1940, Electrochemical Society, annual meeting, Galen Hall, Wernersville. Pa.**

**MAY 13-15, 1940, American Institute of Chemical Engineers, Buffalo.**

**MAY 27-31, 1940, American Petroleum Institute, mid-year meeting, Fort Worth, Tex.**

# BUTYL STEARATE

## Water-White ⋆ Practically Odorless

THE availability of this new grade of Butyl Stearate, water-white in color and practically odorless even after aging, promises to extend greatly the usefulness of this important chemical.

Butyl Stearate is a stable, oleaginous liquid boiling at approximately 225°C. at 25 mm. of mercury. Its oily characteristics have made it of particular value in polishes and coatings which are to be polished, in the compounding of lubricating oils, and as a lubricant in the textile and molding industries. It is used as a plasticizer for laminated fiber products, "synthetic rubber," and special lacquers, and as a waterproofing agent for various materials.

Butyl Stearate also finds use in cosmetic and pharmaceutical products such as vanishing cream, ointments, rouges, lipsticks, nail polishes, and nail polish removers. The freedom from color and odor of this improved Butyl Stearate will be of particular interest to the cosmetic and pharmaceutical industries.

Your inquiry is invited.

### SPECIFICATIONS AND PROPERTIES OF BUTYL STEARATE

***Specific Gravity:*** 0.855 to 0.860 at 25°C./20°C.

***Acidity:*** Less than 0.5%, calculated as stearic acid.

***Water:*** No turbidity when one volume is mixed with nineteen volumes of 60° Bé. gasoline at 20°C.

***Color:*** Water-white.

***Odor:*** Practically odorless.

***Freezing Point:*** Approximately 66°F.

***Flash Point:*** 187.8°C. (370°F.)

***Refractive Index:*** 1.4430 at 20°C.

COMMERCIAL SOLVENTS CORPORATION

17 EAST 42nd STREET, NEW YORK, N. Y.

*PLANTS:* TERRE HAUTE, INDIANA; PEORIA, ILLINOIS; WESTWEGO, LA.; HARVEY, LA.; STERLINGTON, LA.; AGNEW, CALIFORNIA

PROMPT SERVICE FROM BRANCH OFFICES AND WAREHOUSES

# PERSONALITIES

Earle Mauldin

✦ EARLE MAULDIN, engineer and editor who has been identified with southern industries for over 30 years, has joined the staff of *Chem. & Met.* as southern editorial representative. He has headquarters in the Rhodes-Haverty Building in Atlanta where he will also represent *Textile World* and *Food Industries.*

✦ CHARLES M. A. STINE, director of research and vice president of E. I. du Pont de Nemours & Co., received the 34th impression of the Perkin Medal at a joint meeting of the Society of Chemical Industry, American Chemical Society, American Institute of Chemical Engineers, the Electrochemical Society and Societe de Chimie Industrielle, on January 12, 1940. The medal is awarded annually for valuable work in applied chemistry.

✦ LEO W. BRIGGS has joined the staff of the Western Precipitation Corporation of Los Angeles, Calif. where he is now interested in new process development and the utilization of industrial wastes. He was formerly the general superintendent of the Gas Department of the Companhia Energia Rio Grandense at Porto Alegro, Brazil. Following completion of his graduate work at Columbia University, Dr. Briggs was research chemist for the Air Reduction Co. and later was assistant director of the Combustion Utilities Laboratories before going to South America. For the present Dr. Briggs will make his headquarters at Los Angeles.

✦ PAUL W. MCDANIEL, of Everett, Pa., has been named chemical engineer for the Pennsylvania State Department of Health, the Department has announced.

✦ C. E. MCKINNEY and C. J. MINNIG have been promoted to the offices of vice-president in charge of operations and vice-president in charge of sales, respectively, it was announced by Continental Carbon Co., New York. Both officers have been with the company since its inception. Mr. McKinney, formerly superintendent of carbon black operations, will continue to make his headquarters at the company's plant at Sunray, Texas. Mr. Minnig, formerly sales manager, is located at the company's Akron, Ohio, office.

✦ A. LLOYD TAYLOR has become a member of the technical staff of Oakite Products, Inc., and will be engaged primarily at their chemical laboratory at 22 Thames Street, New York City. Research and development on cleaning compounds for production and maintenance cleaning operations of the various major industries is the scope of the work in which Dr. Taylor will be occupied.

✦ FREDERICK M. FEIKER, formerly a McGraw-Hill executive, has resigned his position as executive secretary of the American Engineering Council to become dean of the School of Engineering at the George Washington University. Mr. Feiker succeeds Dean John R. Lapham, whose death occurred in October.

✦ R. Y. WINTERS has been appointed as assistant director of research of the U. S. Department of Agriculture. This position has just been established to facilitate the handling of the increased duties and responsibilities placed upon the director of research, in cooperation with the bureaus of the department, for planning and coordinating the programs of the four new regional research laboratories now being constructed by the department to develop new uses for farm commodities.

✦ F. A. WARDENBURG has been elected to the directorate of E. I. du Pont de Nemours & Co., Inc., to fill the vacancy created by the death of J. B. Edge. Mr. Wardenburg is general manager of the ammonia department of the company.

✦ R. W. MCKEE has been made manager of the Birmingham, Ala., branch of the Hercules Powder Co., Wilmington, Del. F. George Trescher has been named manager of the San Francisco office.

✦ RALPH DORLAND, Eastern sales manager for the Dow Chemical Co., has been elected chairman of the Drug, Chemical and Allied Trades Section of the New York Board of Trade.

✦ JAMES J. MORAN has been appointed to the position of technical manager of the sales department of the Kimble Glass Co., Vineland, N. J.

✦ ISAAC DROGIN has been appointed director of research for the United Carbon Co., Charleston, W. Va. Dr. Drogin was born in Russia and educated in the United States. Since 1922 he had been chief chemist for J. M. Huber Co., Inc., and for six years prior to joining the Huber Co., he was associated with the Mellon Institute.

✦ JAMES F. MCGOVERN, who has served for many years as general counsel of Industrial Alcohol Institute, is continuing the general practice of law as the senior member of the firm McGovern and McCarthy. The Alcohol Institute was discontinued as a trade association on the first of January, but Mr. McGovern takes over the same offices in the Munsey Building, Washington, D. C., which the Institute had for many years.

Hugh K. Moore

✦ W. DEAN KEEFER has joined the Lumbermen's Mutual Casualty Co. as assistant to the vice-president in charge of safety engineering. Mr. Keefer was replaced as a director of the National Safety Council by R. L. Forney, formerly assistant to the managing director.

✦ WILLIAM A. MUDGE has been added to the Technical Service Division of the New York Office of the International Nickel Co. For the past 17 years Dr. Mudge has been superintendent of research, superintendent of the refinery and works metallurgist at the company's Huntington, W. Va., rolling mill.

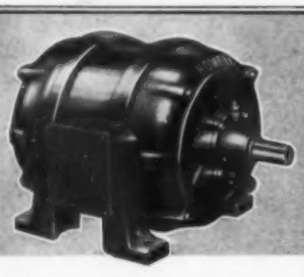
✦ C. L. BACHELDER has been placed in charge of all technical service work of the Paper Makers Chemical Division of Hercules Powder Co. with headquarters at Kalamazoo, Mich.

✦ HUGH K. MOORE, one of the founders of the Technical Association of the Pulp and Paper Industry and chief chemical engineer of the Brown Co., of Berlin, N. H., died Dec. 18 of heart disease. In 1896, after attending the Massachusetts Institute of Technology, Dr. Moore worked for the Electron Chemical Co., of Rumford Falls, Me. In 1897, however, he left in order to develop his own process for the electrolysis of salt, being chemical engineer for the Moore Process and Moore Electrolytic Co. Out of this work came the Allen-Moore cell. Following the development of the electrolytic cell, Dr. Moore became chief chemist and chemical engineer for the Burgess Sulphite Fibre Co., and later he was appointed to the

1915 to 1940 at HOWELL

The Same Ideal for a Quarter Century — "PERFECTION"

Complete Line — for All Types of Process Industry Drives



STANDARD SINGLE and MULTI-SPEED MOTORS, 1/8 to 150 H.P. *Sleeve or ball bearings. More and better insulation. HOWELL-BOND coil varnish — vastly superior. Copper rotors — most dependable construction known. Precision manufacture throughout.*

TOTALLY-ENCLOSED, FAN-COOLED MOTORS, 1/3 to 100 H.P. *Ball bearings. Recommended for use in dusty or fume-filled atmospheres to cut motor maintenance costs.*

SPLASH-PROOF MOTORS, 1/3 to 75 H.P. *Ball Bearings. Give complete protection against splashing or dripping liquids. Ideal for installation out-of-doors.*

. . . . 1940 — HOWELL'S Silver Anniversary Year!

**And today, just as in 1915 when the first HOWELL Motor was wound, every operation of hand and machine is directed toward one ideal: "*To produce the most nearly perfect electric motors.*"**

**This desire to attain perfection still inspires everything done at HOWELL . . . use of finest materials — unhurried craftsmanship — most exacting of final tests.**

***Yes, the hard way to build motors — but what a boon to motor users who have hard drive jobs!***

**Select HOWELL Motors, and you're certain of getting the last word in unfailing performance and low operating costs. We *invite your next motor inquiry.***

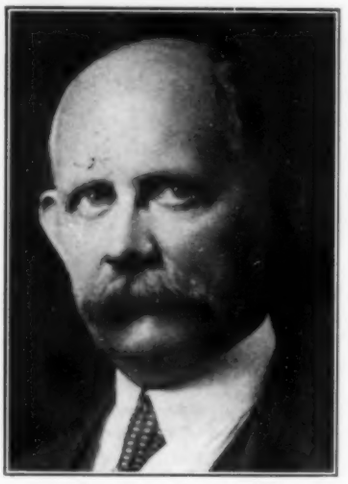
Exacting Tests Such As These Insure that Every HOWELL Motor Measures Up

PRECISION BALANCE TEST — vibrometer check-up with motor operating at full speed, assuring perfect balance of rotor assembly and bearings.

1915 · 1940 HOWELL MOTORS 25th Anniversary Year

HOWELL ELECTRIC MOTORS COMPANY
HOWELL, MICHIGAN
*Representatives In All Principal Cities*


same post with the Brown Co., a combine of several mills of which the Burgess Co. was one. He received the honorary degree of Doctor of Science from the University of Maine in 1924, the Perkin medal of the Society of Chemical Industry in 1925, and during 1926 he was president of the American Institute of Chemical Engineers.



**Joseph F. X. Harold**

✦ JOSEPH F. X. HAROLD, specialist in textile and color chemistry, died Jan. 3 after an illness of three months. Dr. Harold, a graduate of the University of Pennsylvania, had been consultant to the William Grosvenor Laboratories, New York, and was the holder of many textile patents.

✦ HUGO KOBLENZER of North Bergen, N. J., long prominent in the textile chemical business, died last month at the Polyclinic Hospital, New York, after an illness of two weeks. He was 59 years old, and born in Constance, Germany. He traveled extensively and was considered one of the most experienced and widely known men in the textile chemical business.

✦ FRANK LUDLAM, assistant secretary and assistant treasurer of the International Nickel Co., Inc., died on December 8 at his home in New York City, after a long illness. Mr. Ludlam was born at Bloomfield, N. J., on November 3, 1873. After spending several years in architecture and real estate, Mr. Ludlam took a position with the Carnegie Steel Co. at Pittsburgh. He had been with the International Nickel Co. for more than 36 years.

✦ JOHN F. G. MILLER, vice-president of B. B. Sturtevant Co., Hyde Park, Boston, Mass., died suddenly on December 9 of a heart attack at his home in Brookline. Mr. Miller became associated with the Sturtevant Co., in 1933 and was the originator of that company's student sales engineering course which was effective in training and developing many promising young engineers. He was also especially active and influential in trade association matters.

# Readers' VIEWS and COMMENTS

## Magic as an Engineer's Hobby

*To the Editor of Chem. & Met.:*

Sir:—Although a chemical engineer sometimes has to work 28 or 30 hours a day, there are times when he may relax and devote some time to his hobby. The enjoyment and benefit derived from such a change are perhaps directly proportional to the diversity between vocation and avocation. There is certainly a wide gap between chemical engineering and the art of magic and, while I expect to make few new devotees, I'd like to tell how and why it appeals to me.

Magic has changed in meaning from the old idea of sorcery and witchcraft to the present day concept of entertainment by deception. In scientific endeavors, observed effects are followed by reasonable conclusions; but from the spectators' point of view, magic is the antithesis of logical reasoning. The engineer, who daily deals with facts, can find particular enjoyment in the ability to demonstrate that seeing is not believing. What could be more relaxing to the scientific worker than to "prove" to an audience that an object can be in two places at once, or that the law of gravity can be defied?

Prerequisites for engineering are similar to those of prestidigitation. Attention to every detail is necessary for the successful completion of the simplest trick; a planned and logical program is imperative for a smooth and polished performance, and quick thinking is sometimes needed to avoid embarrassment if not disaster. There is no limit to the inventive ingenuity which can be expended on magical tricks and illusions; the scientifically trained performer can often improve standard effects or invent new ones after having mastered underlying principles of the art.

Magic as a hobby has many advantages for an engineer. The ability to address an audience, too often an ability which is woefully lacking in technical men, is greatly improved and a sense of showmanship developed. The study used to discover ways of presentation for maximum effectiveness is applicable to other problems. The work of an engineer is apt to be known to only a few persons. Perhaps he works entirely in a small group. In such instances, performance of magic offers opportunities for meeting people in the company and community who otherwise would not be known. Any unusual ability often results in interesting opportunities. Recently the writer performed in Grand Rapids, Michigan, in the interests of one of the departments of the company with which he is connected. A combination of sales information and magical effects resulted in very suitable entertainment for the type of audience present.

Besides aiding in personal development, magic has many advantages when viewed solely as a hobby. It is inexpensive and some of the most baffling tricks can be performed with a borrowed deck of cards, a commodity almost universally available.

As little or as much time as desired can be spent practicing, and of course correct practice means greater proficiency. There is a universal appeal to people of all ages and in all walks of life. The performance of magic is a pleasure and "it is fun to be fooled"; but it is more fun to do the fooling.

Some of those who may read this will perhaps wonder how to get started and where to learn a few tricks. It must be remembered that magic is one of the oldest arts, and to divulge its secrets promiscuously is harmful to the professionals. To become a magician, a background of psychology of the art and the basic principles upon which it depends is needed. There are many excellent books available treating the different phases of the subject.

It is best to start with simple tricks. Playing cards are familiar and easy to handle, and there are many easy, interesting effects which can be done. Never perform a trick until you are sure of it. Try it out on someone who will offer constructive criticism. Nothing is more embarrassing than a trick that fails. Remember, fool the audience—not yourself.

J. J. Strobel
Chemical Engineer (Dow Chemical Co.)
3619 Concord Street
Midland, Mich.

### AUDITORS AND ENGINEERS

*To the Editor of Chem. & Met.:*

Sir:—At this time each year I have occasion to review the question of audits and auditors. Once again that task brings to mind your several editorials on the subject and prompts me to write to you of my own experience.

Several years ago trustees of a well-known chemical company requested a "detailed audit" at a cost several times as great as the "regular annual audit." The only difference in these audits was a more detailed checking of payrolls, disbursements and other figures. Both systems accepted inventory figures which might have been of the McKesson & Robbins' type.

Because the average accountant is not qualified to check an inventory, I argued that it should be done by an engineer. This has been done each year since that time. In my opinion this should be standard practice in all large corporations. After all, why make an audit unless it is going to be a real one?

P. O'Tash
Consulting Chemical Engineer
New York, N. Y.

### PLUS ENGINEERING

*To the Editor of Chem. & Met.:*

Sir:—I have read with great satisfaction your editorial "Plus Engineering." No single thing in American manufacturing life is so serious as the corporal dishonesty amongst purchasers, principally large purchasers, of engineering and technical equipment. The practice of taking the engineering brains of one company developed specially for the purpose of securing an order and supplying all of that confidential information to competitors for competitive bidding is a most reprehensible and dishonest practice. It has been the cause of more losses to manufacturers and more wrecks of good manufacturing businesses than any other cause. Shortsighted on the part of the purchasers, but they all will do it unless restrained.

A good way to cure this situation is for a manufacturer to submit his confidential engineering information as a basis for a bid with the stipulation that the customer, or prospective customer, is a trustee for the receipt of the information and is obligated to hold it in confidence. Unless the manufacturer who is doing the purchasing is willing to conduct the business on that high basis, then the manufacturer can refuse to deal with him. This, of course, is only effective when a trade association of such manufacturers has a joint enforcible contract between the members to respect this trustee relationship and to decline to bid upon any data which has been supplied by a competitor through a customer. Trade associations can cure this practice by these two contracts, which can be simply worded as mere letters between the parties.

H. A. Toulmin, Jr.
Attorney at Law
Dayton, Ohio

# Chemical Engineer's BOOKSHELF

## Chemurgy on the March Again

PIONEERS OF PLENTY. By *Christy Borth*. Published by Bobbs-Merrill, New York, N. Y. 303 Pages. Price $3.

Reviewed by *Arthur W. Hixon*

ONE WOULD INFER from Mr. Borth that when human history is written in the next generation by a chemurgist, it will be divided into just two eras. In the first, which is even now just vanishing, the events that consumed human lives will be said to have been motivated and controlled by subservience to cosmic processes which produced scarcity, hunger, disease, poverty, belly thinking, unemployment, class hatred and war. The second period, whose dawn light is said to have first faintly appeared shortly after the settling of the country and in whose morning effulgence we are now said to be living, will be characterized by the combating of cosmic processes, the adoption of the scientific habit of thought, the vanishing of hunger and poverty, control of disease, elimination of waste and surpluses, the production of plenty, employment for all, self-sufficiency of nations and disappearance of war. The philosophy of the chemurgist will prevail and the organic chemist will have the leading role.

It is in the beginning of the second era that Mr. Borth's pioneers of plenty occupy the stage. So close is this time to us that some of the pioneers are already living and pioneering.

The dynamic thinkers and workers about whom he has written in the breezy journalistic mode of the day are William Jay Hale, rampant chemist and father of chemurgy, Charles Holmes Herty, cellulose and paper chemist, Francis Patrick Garvan, lawyer and militant champion of American chemical industries, Leo Hendrick Baekeland, world famous industrial chemist and founder of the modern synthetic plastic industry, Henry Ford, peerless automobile builder and advocate of the wedding of agriculture and industry and George Washington Carver, modest negro chemist of the Tuskeegee Institute.

The real accomplishments of each of the pioneers are so well known to chemists and chemical engineers that there is no need to comment upon them.

The book has some historical importance. It presents for the first time a record of the events out of which developed the farm chemurgic idea and enterprises as we know them today. The genesis of the idea and the essential elements of its philosophy are expressed by Mr. Borth as follows:

"Here, he (Wheeler McMillan) said is a new problem. . . . too many mouthfuls and too few mouths! . . . . But the solution eluded him until he heard a business man sum up a discussion of the wheat surplus with the remark, 'Unfortunately, the human stomach is not elastic.' . . . Then a startling idea struck him. Maybe, he said, the scientist is a better Santa Claus for the farmer than the politician is. Maybe the answer to the problem is the development of non food uses for farm products. Yes, that looks like the solution; for though the consumption of food is definitely limited by the easily satisfied appetite for it, the non food appetites of man are limited only by purchasing power. Yes, that looks like the idea said McMillan reaching for paper and pencil . . . Thus, simultaneously the chemurgic idea appeared in two places in print. . . . Hale thought of raw materials for industry, and McMillan thought of non food uses for farm products."

There is no doubt in this reviewer's mind that the chemurgic idea and philosophy have much to recommend them, and that they will have an important part in the solution of the farm problem. However, the Santa Claus aspect of the movement which has been stressed by some chemurgic protagonists and politicians is unfortunate and perhaps dangerous. The scientist is not going to present the farmer with a solution for his problems in the form of a bag full of "wonders of Chemistry" on Christmas morning. The establishment of the four regional research laboratories by the U. S. Department of Agriculture to find new non food uses for agricultural surpluses and wastes does not mean that the farm problem will be solved next year or the following year. It does mean that the government has taken notice of the chemurgic idea and that an agricultural research program with a new point of view will be tried. That results will be obtained in time which will be useful in helping to solve farm problems and some of those of industry there can be little doubt. It is a long time program. The sooner we can get rid of the Santa Claus method for solving problems of government and industry, which is so prevalent in this country today, the better off we will all be.

The announcement of the beginning of the chemurgic historians' second era does not mean that the millenium is here nor that it is just around the corner. However, the focusing of the research efforts of the scientist and particularly those of the chemist and chemical engineer on some of our most vexing social and industrial problems is a mighty hopeful sign. The chemurgic movement has been helpful in bringing this about. Mr. Borth's imagination has been so completely captured by the promises for the New Day that he has permitted his reportorial enthusiasms to run away with him a bit. He has not been as critical of some of his statements of facts as he should have been. Time will make the true appraisal of the works of his pioneers. Some of them will rank high. The book was written for the man and woman in the street. They will like it.

### FUEL REPORTS

SYMPOSIUM ON THE COMBUSTION OF SOLID FUELS. Available from Gilbert Thiessen, Secretary, Division of Gas and Fuels, 6625 Woodwell St., Pittsburgh, Pa. 117 pages. Price 75 cents (paper).

THIS IS A PREPRINTING of the papers presented at the symposium of the A.C.S. Division of Gas and Fuel Chemistry, Boston meeting, September 1939. The volume contains eleven papers. The list of authors includes representatives of many of the foremost laboratories concerned with the problems of fuel and combustion not only in this country, but also in England and the Continent. The topics range from studies of the chemical kinetics of combustion reactions to a consideration of the space required for the combustion of pulverized coal, and include several papers concerned with the measurement and significance of the ignitibility of solid fuel.

COAL UTILIZATION PAPERS. Circular Series No. 39 of the University of Illinois, Bulletin dated October 10, 1939. 173 pages. Price 50 cents (paper).

THIS IS A PRINTING of the series of lectures presented under the auspices of the Engineering Experiment Station at the University of Illinois in May, 1939 as a "Short Course in Coal Utilization". In the aggregate, it is a small manual which should assist operating engineers in securing better efficiency in their fuel departments.

ANNUAL STATISTICS OF GAS INDUSTRY. Statistical Bulletin No. 36 on manufactured gas and Statistical Bulletin No. 37 on natural gas. Published by American Gas Association, 420 Lexington Avenue, New York, N. Y. 27 pages and 15 pages, respectively.

THESE TWO PAMPHLETS taken together give a composite statistical picture

of activities of the public utility gas business in 1938, one bulletin relating to manufactured gas and the other to natural gas. Figures are given on production, sales, consumption by uses, unit costs, customers and other details of engineering significance.

GAS PURIFICATION. Pamphlet reports from the Technical Section of American Gas Association, 420 Lexington Avenue, New York, N. Y.

OF IMPORTANCE to chemical engineers are two special reports presented at the Technical Section of A.G.A., October, 1939 meeting in New York. These are available in preprint form as "Organic Sulphur", by R. E. Kruger, Rochester Gas and Electric Corp. 41 pages, a part of the gas conditioning committee report that reviews methods for processing fuel gases for sulphur removal. "Ten Years of Gas Dehydration", by W. L. Shively, Koppers Company, Pittsburgh, 14 pages, is a resume of the economic and technical factors involved in drying of gases for city distribution. The engineering data and cost estimates would be readily adaptable to analogous gas processing in various divisions of chemical process industry.

POSSIBILITIES OF RESEARCH IN THE GASIFICATION OF COAL, by *C. A. Barnes*, Fuel Research Laboratory, Batelle Memorial Institute, Columbus, Ohio, as Technical Report No. V of Bituminous Coal Research, Inc., 803 Southern Building, Washington, D. C. 36 pages. Price 15 cents.

TO BROADEN THE MARKET for bituminous coal, this review of the economics and technology of gas manufacture primarily considers methods for the complete gasification of coal without by-products, and emphasizes the production of gas suitable for city main distribution. Conclusions, in general, are that gas manufactured from coal cannot compete on a cost per therm basis with either coal or natural gas, but rather upon basis of its premium qualities of convenience, cleanliness, and specific adaptability for certain purposes.

THE A.S.T.M. STANDARD SPECIFICATIONS FOR CLASSIFICATION OF COAL AS APPLIED TO CANADIAN COALS. National Research Council Publication No. 814. 26 pages. Published by National Research Council of Canada, Ottawa. Price 25 cents.

THIS REPORT undertakes to apply to Canadian fuels the A.S.T.M. classification of coals by rank and grade. It is important to any industrial unit which finds it economical to purchase or process Canadian solid fuel.

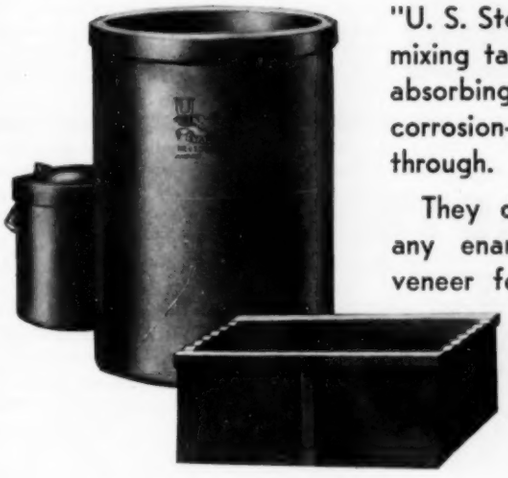
## SOCIAL IMPLICATIONS

SCIENCE FOR THE WORLD OF TOMORROW. By *Gerald Wendt*. Published by W. W. Nofton Co., Inc., New York, N. Y. 316 pages. Price $2.75.

DR. WENDT has written an interesting book about the role science has played thus far in the development of civiliza-


# FOR ACID STORAGE AND MIXING—

## SPECIFY "U. S. STANDARD" CHEMICAL STONEWARE



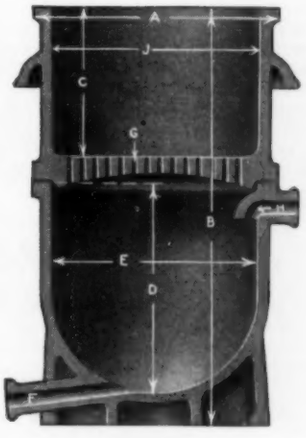
"U. S. Stoneware" storage and mixing tanks are sanitary, non-absorbing and acid, alkali and corrosion-proof all the way through.

They do not depend upon any enamel lining, glaze or veneer for their sanitary and acid-proof qualities. The close-grained, non-porous body does not absorb objectionable odors nor does the surface become slimy. Well-rounded corners make cleaning easy.

Prompt shipment can be made of standard vessels, in all sizes and designs, with or without outlets, drain faucets, or covers. Special sizes or shapes can be made to order. *SEND FOR BULLETIN NO. 405.*

## SUCTION FILTERS

A full line of air-and-vacuum tight Suction and Gravity Filters guaranteed acid, alkali and corrosion-resistant. Stocked in five standard types from small laboratory sizes to large heavy-duty industrial units, able to withstand a complete vacuum. *SEND FOR BULLETIN NO. 410.*

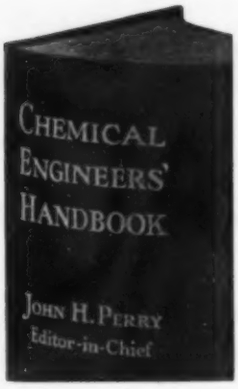



### *OTHER "U. S. STONEWARE" PRODUCTS*

JAR MILLS
LABORATORY SINKS
VALVES AND FAUCETS
TOWERS
COOLING COILS
TOURILS
SUCTION FILTERS
RECEIVERS
KETTLES
EXHAUSTERS
CENTRIFUGAL ACID PUMPS
ACID-PROOF BRICK
MIXERS
ACID-PROOF CEMENTS
CORROSION-RESISTANT TANK LININGS

**THE U. S. STONEWARE CO.**
AKRON (Since 1865) OHIO

*Now available on small monthly payments*




*Perry's*

**CHEMICAL ENGINEERS' HANDBOOK**

**30 sections, 2609 pages, 4½ x 7, profusely illustrated, $9.00**

NOW you can start using Perry's new Handbook at once—paying in small monthly installments while you use it. No strings to the offer—no mark-up to cover installment charges—no difference in quality of the book. Just a special offer to urge action. Whether you are a practicing engineer, executive, plant or laboratory worker, or mechanical engineer—no matter what your question—whether directly concerned with unit operations, or afield in such subjects as Plant Location, Patent Law or Fire Protection—you are sure to find it answered here—concisely explained and illustrated, authoritatively handled by a specialist, and instantly accessible. The *Journal of the Patent Office Society* says, ". . . definitely supplies a long-needed tool for all concerned with the industrial applications of chemistry."

The treatment is concise and well-illustrated, and is supplemented by a profusion of comprehensive formulas and equations, charts, tables, data, schematic diagrams, etc. Throughout, the material has been arranged for quick reference to the essentials required by men in practical contact with chemical engineering problems of all types.

***10 days examination — Easy monthly payments***

**SEND THIS COUPON TODAY**

**McGRAW-HILL BOOK CO., INC.**
**330 West 42nd Street, New York City**

Send me Perry's Chemical Engineers Handbook for 10 days' examination on approval. In 10 days I will send $3.00, plus few cents postage, and $3.00 monthly for two months thereafter, or return book postpaid. (Postage paid on orders accompanied by remittance.)

Name .....

Address .....

City and State .....

Position .....

Company .....M. 1-40

(Books sent on approval in U. S. and Canada only.)

tion as well as its prospective role in the World of Tomorrow. It is not a scientific book in the strictly technical sense, but it is a book that merits reading by every scientist, technician and engineer for its novel point of view.

That the development of the principles of social living have not kept pace with scientific development is a generally accepted fact. The author shows how the scientific method has benefited civilization and how it is continuing today to go forward and make this world, if not a better one for human beings, at least a more comfortable and leisurely one. His claim is that since science has done so well in the development of material things, the scientific method is needed to help us solve our social problems. Science should not be viewed merely as a great body of knowledge or a large collection of useful instruments, gadgets and machines. Science is essentially a method of solving problems and the problems are essentially those of human beings. Engineering, and all professions using the scientific method, can help this world solve its social problems by encouraging the use of the scientific method of research, discussion and tolerance in other fields. Too many technical men confine themselves to their scientific conventions or technical meetings and too few envision the part they can play in influencing our retarded social development by helping to spread their scientific methods to the latter field that needs their help so much. We repeat, Dr. Wendt's book is not a technical book. It might rather be classified as a history and philosophy of the achievements and possibilities of science.

The material is divided into two general classes, historical and philosophical. After the history of the development of the raw materials we have their general application to mechanical devices.

On the philosophical side we have the expression of social ideas which result from industrial applications. For example, the author feels that the goal of human intelligence must be the enrichment of life in all respects as a result of scientific endeavor; that we are justified in turning to science for suggestions as to method; that membership in any group is a real human need; it is the function of the interpreters of science to reveal the scientific attitude; on the whole we have been more interested in utilizing science than in understanding it. In the words of the author "the path from gunpowder to the latest evening gown is straight and narrow", but few scientists realize the great social significance of this statement.

The author's references to the New York World's Fair (of which he is Science Director) seem to be a bit irrelevant to the lofty aim of his book. However, no engineer will regret reviewing with Dr. Wendt the grandeur of the profession of which he is a part.

THE STOREHOUSE OF CIVILIZATION. By *C. C. Furnas.* Published by Bureau of Publications, Teachers College, Columbia University, New York, N. Y. 562 pages. Price $3.25.

THE PREFACE BY THE EDITOR states that this book has been prepared primarily for teachers of science. However, its clearness of presentation of usually highly technical material offers to the public at large a background of technological developments plus an interpretation of their effect on our general economic and social life. In other words, we have a vast industrial panorama produced as a result of scientific discovery and development and with this as a basis, we must produce and, even more important, distribute the goods of the world.

The author believes that in order to maintain an effective democracy, the voting public must be well informed not only on the immediate political issues, but the more remote social and economic factors upon which such issues must of necessity be based. The so-called branches of science cannot be divorced from the science of living. They are mutually interdependent. Pure scientific discovery and research without any practical and significant application might give satisfaction to the individual scientist, but in the light of the world at large it would certainly be completely useless.

While the book is divided into ten chapters it appears that the first nine fall naturally into one group and the tenth stands alone. The first group describes clearly and simply, although with considerable detail, the sources of minerals and other raw materials, the chemical processes employed in their conversion to articles of commerce and finally, the numerous uses to which the manufactured products are put.

The last chapter, on the other hand, deals with the production and distribution of these goods as economic factors and with the social implications involved therein. Included in the subheadings in this chapter are such things as man versus machinery; trend in working hours; inanimate services; the slow pace of change; industrial giants; the optimum size; agriculture is an industry; social malpractices in industrial communities; and when is international trade desirable?

This list gives only a few of the more significant headings. Therefore, of necessity, one volume such as this can scarcely do more than touch upon each subject. However, one of the merits of this book lies in the fact that while it treats briefly of many things, at the same time, it does so sufficiently adequately and accurately to stir up a desire in the reader to learn more about the scientific aspects and in addition, much thought is stimulated concerning the social and economic implications.

THEORETICAL ELECTROCHEMISTRY. By *N. A. McKenna.* Published by D. Van Nostrand Co., Inc., New York, N. Y. 469 pages. Price $5.50.

IN THE LAST FEW YEARS the theory of solutions has come to imply the theory of electrically conducting solutions. In the first part of this book an attempt has been made to emphasize the theory of interionic attraction and to show how the properties of ionic solutions fall into well defined groups. A second section of the book is devoted to the thermodynamics of reversible cells and the theories of the galvanic cell.

INDUSTRIAL HEALTH. By *C. O. Sappington.* Published by Industrial Commentaries, Chicago, Ill. 224 pages. Price $3.75.

FORMERLY DIRECTOR of Industrial Health for the National Safety Council and lecturer on Industrial Hygiene at several of our well known universities and medical schools, Dr. Sappington certainly appears more than well qualified to write a book on this his major field of interest. Even after a quick reading two things stand out in this work. In the first place, the author gets right down to brass tacks and tells what specific and practical things industry must do in developing a health program. There are twenty-five blank forms appended to the work which the author feels could be used profitably by industrial organizations. The first group includes a detailed physical examination with space for re-examinations. These forms include not only health at the time of examination, but family health history, previous health record of the individual and most important of all, occupational health history. A subsequent group of charts covers industrial welfare data for the individual plant and includes such items as cost of illness per annum, causes, number of employees exposed to these causes etc. With all these data carefully and accurately compiled for each plant and each individual worker, the employer should be able to do much to improve the health standards of his group.

In the text proper Dr. Sappington discusses in detail many of the most frequent health hazards and gives simple methods for eliminating them. These general subjects include many simple things common to most industries and the causes of a very large percentage of general ills. Among these are included fatigue, posture, noise, nutrition, mental hygiene, recreation, ventilation and illumination. Practical illustrations are given which point out the actual savings in dollars and cents for the employer who follows certain simple precautions.

The second outstanding thing about the book is the absence of philosophical dribble. The author feels that business is a practical matter and everything connected with it is more or less practical. Thus, so-called paternalism can play no part in real, down-to-earth business. He does not feel that the man who provides good working hours and safe conditions of work for his employees, thus ultimately reducing his own expenses and increasing his net profit, is an altruist, but rather a hard headed, sensible business man. Each such business man should provide those things required for the health and safety of his employees and thus eliminate the taxation, frequent law suits etc. engendered when this type of thing is left to the devices of the government. Such costly laws, costly from the standpoint of administration as well as enforcement, as the Wagner Labor Relations Act and the Wage and Hour Bill would be quite unnecessary if each individual employer saw to it that his working conditions, both mental and physical, were what they should be, adequate, decent and fair.


**RYERSON *Certified* STEELS**

**IN STOCK . . . IMMEDIATE SHIPMENT**

Over 40 kinds of alloy steels—both standard S.A.E. analysis, and special heat treated Ryerson alloys—are included in the wide range of Certified Steel products carried in Ryerson stock for Immediate Shipment.

A special quality control plan on alloy steels gives the heat treater exact data on every bar to guide him in securing better results in less time. Write for complete information.

If you do not have the blue and grey Ryerson Stock List — the Key to Immediate Steel — we will gladly send a copy. Joseph T. Ryerson & Son, Inc. Plants at: Chicago, Milwaukee, St. Louis, Detroit, Cincinnati, Cleveland, Buffalo, Boston, Philadelphia, Jersey City.

*Principal Products Include:* Bars, Shapes, Structurals, Plates, Sheets, Floor Plates, Alloy and Tool Steels, Allegheny Stainless, Screw Stock. C. F. Shafting, Mechanical Tubing, Reinforcing Steel, Welding Rod, Nuts, Bolts, Rivets, etc.

**DATA SHEETS**

**. . . On Materials of Construction 1938–1939 Edition**

**Literally a Materials Handbook, this 38-page booklet presents essential information for more than 800 corrosion-, heat- and abrasion-resistant materials used in the construction of process equipment.**

**Included are: (a) non-ferrous metals and alloys, (b) ferrous metals and alloys and (c) non-metallic materials of construction. Physical properties, chemical composition and names of manufacturers are given.**

**Ask for *DATA SHEETS—1939***

**Chemical & Metallurgical Engineering, 330 West 42nd St., New York, N. Y.**

**Stearns MAGNETIC**

**SEPARATORS • DRUMS • ROLLS**
**CLUTCHES • BRAKES • MAGNETS**

Offer numerous features in design and construction that many years of research and development have built into STEARNS products.

America's leading industries depend on STEARNS magnetic equipment for maximum operating efficiency at low costs in such problems as separations, protection, purification, reclamation, concentration or power transmission. They know STEARNS MAGNETIC means quality, durability and dependability.

Magnetic equipment may be the solution of your problem. We invite your questions. Consult magnetic headquarters.

**Write for Our Bulletin 100 Containing data on Stearns Magnetic Applications**

**629 So. 28th Street Milwaukee, Wis.**

**STEARNS MAGNETIC MFG. CO.**

# Government PUBLICATIONS

*Documents are available at prices indicated from Superintendent of Documents, Government Printing Office, Washington, D. C. Send cash or money order; stamps and personal checks not accepted. When no price is indicated, pamphlet is free and should be ordered from bureau responsible for its issue.*

**Shoshone Anticline, Near Cody, Wyoming.** U. S. Geological Survey, Division of Information release of November 18, 1939. Gives information on petroleum resources and possibilities of the Shoshone anticline, preliminary to a more detailed report on this region to be released later. Available only from U. S. Geological Survey; mimeographed.

**Geology and Fuel Resources of the Southern Part of the Oklahoma Coal Field.** Part 4. The Howe-Wilburton District, Latimer and Le Flore Counties, by Thomas A. Hendricks. U. S. Geological Survey Bulletin 874-D; 70 cents.

**Hazard of Mercury Vapor in Analytical Petroleum Laboratories,** by C. F. McCarroll. Bureau of Mines, Report of Investigations 3475; mimeographed.

**Dust Produced by Drilling When Water is Sprayed on the Outside of the Drill Steel,** by John A. Johnson and Wing G. Agnew. Bureau of Mines, Report of Investigations 3478; mimeographed.

**Petroleum Refineries, Including Cracking Plants, in the United States, January 1, 1939,** by G. R. Hopkins and E. W. Cochrane. Bureau of Mines, Information Circular 7091; mimeographed.

**Some Fundamentals of Smoke Abatement,** by J. F. Barkley. Bureau of Mines, Information Circular 7090; mimeographed.

**Properties of a Petroleum-Reservoir Liquid and Its Residua with Applications of the Data to Production Problems,** by Kenneth Eilerts, R. Vincent Smith, and Alton B. Cook. Bureau of Mines, Report of Investigations 3474; mimeographed.

**Federal Specifications.** TT-P-91, Paint; rubber-base (for), cement-floors. TT-V-86, Varnish, rubbing; cabinet. ZZ-B-426, Blankets; rubber. ZZ-S-311a, Sheeting; rubber. 5 cents each.

**Federal Specifications.** P-P-556a, Polish; Metal. P-P-571b, Polish; Silver. TT-V-61, Varnish; Damar. TT-P-641, Primer, Paint; Zinc Dust-Zinc Oxide (For Galvanized (Zinc-Coated) or Zinc Surfaces). W-B-131b, Batteries, Storage; Ignition, Lighting, and Starting. 5 cents each.

**Electric Batteries and Standard Cells:** Publications by Staff of Bureau of Standards. National Bureau of Standards; Letter Circular 553; mimeographed.

**Standards and Specifications for Building and Construction Materials, Fixtures, Supplies, and Equipment.** National Bureau of Standards, Letter Circular 570; mimeographed.

**List of Common Names Used for Species of Derris in Connection with Insecticidal Properties,** by R. C. Roark. Bureau of Entomology and Plant Quarantine, E-477; mimeographed.

**Control of the Earworm in Sweet Corn by Fumigation,** by George W. Barber. Bureau of Entomology & Plant Quarantine, E-485; mimeographed.

**Selected References on Solid Carbon Dioxide.** Bureau of Agricultural Chemistry and Engineering; mimeographed.

**Agricultural Statistics, 1939.** U. S. Department of Agriculture, 60 cents (paper).

**The Cost of Distributing Power.** Tennessee Valley Authority. Available only from Tennessee Valley Authority, Knoxville, Tenn.; unnumbered pamphlet.

**Digest of State and Federal Labor Legislation, Enacted July 1, 1938 to July 1, 1939.** Division of Labor Standards, Bulletin No. 32; 10 cents.

**Statistics of Income for 1937,** Preliminary Report of Corporation Income and Excess-Profits Tax Returns Filed through December 31, 1938. Bureau of Internal Revenue; 5 cents.

**Structural Clay Products,** by J. Joseph W. Palmer. Bureau of Foreign and Domestic Commerce, Trade Information Bulletin No. 842; 10 cents.

**Carbon Bisulphide Vapour.** Leaflet No. 6, Methods for the Detection of Toxic Gases in Industry, Department of Scientific and Industrial Research. Available from The British Library of Information, 50 Rockefeller Plaza, New York City, 10 cents. A resume of the hazards of carbon bisulphide and recommendations for detection.

**Water Pollution Report, 1938.** His Majesty's Stationery Office, London. Available from British Library of Information, 50 Rockefeller Plaza, New York, N. Y. 57 pages, 30 cents. This annual report of the Water Pollution Research Board summarizes investigations on activated sludge, sewage disposal, sewage colloids, milk products effluent handling, and some of the fundamentals of mud formation, sedimentation, and control of suspended matter in tidal waters. The conclusions would be applicable to American process industry situations of a comparable nature.

**Power Capacity to Meet National Needs.** Published by Chamber of Commerce of the United States, Washington, D. C. 22 pages. A statistical resume undertaking to prove that power utilities under private ownership can care for the needs of American industry even in time of military emergency.

**Commerce and Economic Resources of Our Outlying Territories and Posessions, Revision of November 1939.** Published by Chamber of Commerce of the United States, Washington, D. C. 50 pages. A statistical resume of trade between continental United States and the territorial, insular, and other posessions.

**Palladium as a Catalyst.** Bibliography of Patents, Part 1, United States and German Patents. Published by Baker & Co., Inc., 113 Astor St., Newark, N. J. A resume of the reactions catalyzed, the types of organic industrial applications, and special inorganic chemical uses which have been described in the patent literature.

**Crude Rubber.** Comprehensive statistical report of world supply and consumption. U. S. Tariff Commission; unnumbered mimeographed document.

**Naval Stores.** Fourth semi-annual report on production, distribution, consumption and stocks of turpentine and rosin,, April 1-September 30, 1939. Bureau of Agricultural Chemistry and Engineering; mimeographed.

**Tax Regulations.** Relating to gasoline, lubricating oil, and matches. Bureau of Internal Revenue, Regulations 44, 1939 edition. Published in Federal Register, November 22, 1939; 10 cents.

**Fuel Oils** (Fifth Edition). Bureau of Standards, Commercial Standard CS12-40. Mimeographed advance release available only from Bureau. Later to be printed.

**Food and Life**—Yearbook of Agriculture 1939. U. S. Department of Agriculture; $1.50.

**The Mineral Industry of Alaska in 1938,** by Philip S. Smith. U. S. Geological Survey, Bulletin 917-A; 35 cents.

**Soda Ash.** Federal Specification O-S-571a; 5 cents.

**Ground Water Supply.** Water levels and artesian pressure in observation wells in the United States in 1938. U. S. Geological Survey Water-Supply Paper 845; 75 cents.

**The Work of an Industrial Hygiene Division in a State Department of Labor.** Division of Labor Standards, Bulletin No. 31; 10 cents.

**Grapes, Raisins and Wines.** U. S. Tariff Commission, Report No. 134, Second Series; 60 cents.

**U. S. Government Manual, October 1939.** A directory of government agencies with statement of functions, scope, and organization, published quarterly. Office of Government Reports; $2 (paper), $3.50 (cloth) for annual subscription. $0.75 (paper), $1.25 (cloth) for single edition.

**Reciprocal Trade with Canada.** Agreement effective June 17, 1939. State Department, Executive Agreement Series No. 149; 10 cents.

**The European War and United States Imports.** U. S. Tariff Commission; mimeographed.

**Strategic Minerals Investigations,** by John W. Finch. Procedure followed by the Bureau of Mines, Bureau of Mines, Information Circular 7097; mimeographed.

**Fuel Tables.** Coke and byproducts and lignite statistics of production for 1938. Bureau of Mines; mimeographed.

**Comparative Charts of State Statutes illustrating Barriers to Trade Between States.** The Marketing Laws Survey, Works Progress Administration; 25 cents.

**Crushing Cottonseed Cooperatively,** by John S. Burgess, Jr. Farm Credit Administration, Circular No. C-114; 10 cents.

**Manganese and Its Alloys,** by R. S. Dean, C. Travis Anderson, Cresap Moss, and P. M. Ambrose. Bureau of Mines, Report of Investigations 3477; mimeographed.

**Bureau of Mines—A.P.I. Pressure Core Barrel (Progress Report on its Design and Development),** by D. B. Taliaferro and R. E. Heithecker. Bureau of Mines, Report of Investigations 3481; mimeographed.

**Grades and Yields of Rosin and Turpentine from Crude Gum,** by A. R. Shirley. Bureau of Agricultural Chemistry and Engineering, ACE-5; processed.

**Report of Studies on Uniformity of Quality of Sugars.** Bureau of Agricultural Chemistry and Engineering, ACE-3; processed.

**Role of Enzymes in Relative Value of Cottonseed,** by G. S. Meloy. Address before American Oil Chemists Society. Bureau of Agricultural Economics; processed.

**Field Method for Chemical Evaluation of Spray Deposits Resulting from Application of Insecticides for Control of Codling Moth,** by Jack E. Fahey and Harold W. Rusk. Bureau of Entomology and Plant Quarantine, E-491; processed.

**Laboratory-Field Method for Testing Codling Moth Insecticides,** by L. F. Steiner. Bureau of Entomology and Plant Quarantine, E-488; processed.

**Bibliography of Cyanide Compounds Used as Insecticides,** by H. D. Young. Bureau of Entomology and Plant Quarantine, E-493; processed.

# WORTHINGTON

# 100 YEARS

# 1840 - 1940

## "WHAT IS RIGHT WILL PROVE ITSELF RIGHT"

THUS WROTE Henry R. Worthington, a great engineer-inventor, in 1876. He continued, "I have asked for an answer to the question . . . Have I been able permanently to improve the department of engineering, in which I have steadily and exclusively worked?"

» Today, the company which he founded, its products in use in every country in the world, with plants that cover hundreds of acres, with the value of its manufactures reaching hundreds of millions of dollars, looks back over a century's span, and sees proved the essential soundness of its founder's vision and ideals.

» In its century of growth it has pioneered in many significant basic engineering developments of widespread application. Itself a pioneer, it has pushed forward shoulder to shoulder with pioneers, across continents and over the seven seas. It has witnessed the birth and growth of a new age. It has seen a whole new civilization develop, and has accepted the continued challenges of that civilization. Looking back on its rich and fruitful past, it turns to its second century confident of its ability to carry on with the splendid spirit and vision of its founder.

» Worthington's maturity finds expression in a notable group of engineering products with standards of excellence and records of performance unsurpassed in their respective fields . . . for the petroleum industry in production, transportation and refining . . . for gas and oil pipe lines and distribution . . . for refrigeration and air conditioning in every branch . . . for steam power, land and marine, including turbines, condensers, feedwater heaters and auxiliaries . . . feedwater heaters for railway locomotives . . . Diesel and gas engine units covering a wide power range . . . air and gas compressors for all industrial uses . . . a comprehensive line of contractor equipment . . . and pumping equipment whose scope is the most extensive available.

» It has been said that an institution is the lengthened shadow of a man. Perhaps more true of the Worthington Pump and Machinery Corporation than of most institutions, it yet is not the whole truth. This corporation is not only the lengthened shadow of one man, but of many men who have given the best of their keen minds and stout hearts, that their science and engineering could better serve not only their company but also the civilization of which they and it have been such important parts.

Harry G. Beaver

PRESIDENT

WORTHINGTON PUMP AND MACHINERY CORPORATION
HARRISON, NEW JERSEY

Moore Steam Turbine Division . . . Carbondale Air Conditioning and Refrigeration Division
Worthington-Gamon Meter Company

M10-1

# Manufacturers' LATEST PUBLICATIONS

**Apparatus.** American Instrument Co., 8010 Georgia Ave., Silver Spring, Md. —Leaflet CM2070—4 pages describing the latest improved type of this company's Magne-Gage for non-destructive magnetic measurement of thickness of coatings on meals; also bulletin CF2074, describing a new bonded-abrasive wheel cutoff machine for cutting glass, ceramics, metals and other materials in sheets, rods, tubes and blocks up to 3½ in. thick, (or 6 in. in materials that can be rotated.)

**Electrical Equipment.** Delta Star Electric Co., 2400 Block, Fulton St., Chicago, Ill.—Price List 65-2—32 pages covering a complete line of cable terminators and potheads.

**Electrical Equipment.** Durakool, Inc., 1005 North Main St., Elkhart, Ind.—4-page advertisement reprint from *Fortune* magazine, describing performance and construction of Durakool mercury switches and reasons for success of this construction.

**Electrical Equipment.** Roller-Smith Co., Bethlehem, Pa.—Catalog 8-b—12 pages on this company's latest types of moderate-duty metal-clad switchgear for indoor service at capacities of 400 to 2,000 amp., up to 5,000 volts.

**Electrical Equipment.** Westinghouse Electric & Mfg. Co., Department 7-N-20, East Pittsburgh, Pa.—Catalog 30-000—59-page "Quick Selector" catalog, designed to help users select correct equipment for motor or lighting circuits, with information on mounting and connecting for convenience and safety.

**Equipment.** Bradley Washfountain Co., Milwaukee, Wis.—Leaflet P257—4-pages briefly describing a broad range of factory wash-room equipment made by this company.

**Equipment.** Eppenbach, Inc., 45-10 Vernon Blvd., Long Island City, N. Y. —Catalog 401—8 pages describing construction features of this company's colloid mills; also catalog 402, 4 pages on Eppenbach Homo-Mixers for high intensity mixing without incorporation of air.

**Fans.** American Machine & Metals, Inc., DeBothezat Ventilating Equipment Div., East Moline, Ill.—12-page bulletin on DeBothezat Bifurcators with information on construction of various types of these novel duct-mounted ventilating fans, and capacity and dimension tables.

**Filters.** Morse Bros. Machinery Co., P.O. Box 1708, Denver, Colo.—Bulletin 910—8-page leaflet describing this company's continuous vacuum drum and disk filters, with information on accessories.

**Fittings.** Tri-Clover Machine Co., Kenosha, Wis.—Loose-leaf catalog, giving sizes and dimensions on a considerable variety of industrial-type stainless steel fittings made by this company.

**Flashlights.** Chargit Corp., Anderson, Ind.—Booklet describing in detail this company's flashlights with rechargeable batteries; also charging equipment and accessories.

**Flexible Tubing.** Chicago Metal Hose Corp., Maywood, Ill.—Bulletin SS-16—4-pages on "Rex-Bellows" stainless steel flexible tubing available with a variety of different bellows arrangements.

**Grinding.** Abbé Engineering Co., 50 Church St., New York City—Catalog 49 —12-page catalog on this company's plant size ball and pebble mills, with engineering data and information on construction features.

**Heaters.** L. J. Wing Mfg. Co., 154 West 14th St., New York City—Bulletin U-4C—12 pages describing and giving engineering data on this company's latest type of unit heater, with brief information on other special types of unit heater and other ventilating products.

**Instruments.** Brayer Instrument Co., 1615 William St., Buffalo, N. Y.—4-page folder describing the Fluidometer automatic liquid metering system for the batching of liquids with better than commercial accuracy.

**Instruments.** The Foxboro Co., Foxboro, Mass.—Bulletin 198-2—40 pages on this company's recording thermometers for industrial use, with detailed information on types and accessories.

**Instruments.** General Electric Co., Schenectady, N. Y.—Bulletin GEA-3339 —8 pages on general-purpose automatic time switches, Type T-27.

**Instruments.** Leeds & Northrup Co., 4934 Stenton Ave., Philadelphia, Pa.—66-page condensed catalog listing this company's entire line of testing instruments for laboratory, plant and field use, including various standard resistors, etc., galvanometers, bridges, potentiometers, thermocouples, pH electrodes and other devices.

**Instruments.** C. J. Tagliabue Mfg. Co., Park and Nostrand Aves., Brooklyn, N. Y.—Catalog 1100B—18-page catalog on laboratory thermometers and hydrometers, with gravity and temperature conversion tables.

**Joint Compounds.** Macksons Co., 125 Cedar St., New York City—4-page booklet on this company's joint sealing compounds for piping and industrial equipment, describing two types of compound, for use in the majority of process piping applications.

**Materials Handling.** Robins Conveying Belt Co., 15 Park Row, New York City—Bulletin 109—4-page leaflet briefly describing and illustrating a broad range of materials handling equipment as well as crushers and screens made by this company.

**Metal Belts.** Audubon Wire Cloth Corp., Richmond St. and Pastor Ave., Philadelphia, Pa.—Catalog 50-15—43-page catalog on this company's woven metal belts for continuous conveying and processing, describing numerous types of weave, listing specifications and giving information on installation.

**Pipe.** Walworth Co., 60 East 42d St., New York City—4-page folder on this company's Ni-Resist pipe, with information on corrosion resisting characteristics, and applications.

**Ply-Metals.** Jessop Steel Co., 518 Green St., Washington, Pa.—24-page booklet on this company's Silver-Ply stainless-clad steels with information on resistance of various types of cladding to corrosion by almost all substances encountered in process industries; includes information on fabrication methods and welding.

**Power Transmission.** Farrel-Birmingham Co., 344 Vulcan St., Buffalo, N. Y. —Catalog 443—44 pages on this company's Gearflex flexible couplings. Shows construction, applications, and rating and dimensional information of numerous types.

**Pumps.** Tri-Clover Machine Co., Kenosha, Wis.—Form 153-5—6-page booklet, describing and giving engineering data on this company's Tri-Clover centrifugal pumps.

**Rectifiers.** Allis-Chalmers Mfg. Co., Milwaukee, Wis.—Bulletin B6064—40-page 1939 edition of this company's book on mercury arc rectifiers with information on construction, uses and advantages. Covers both multi-anode types and the new Excitron single-anode rectifiers. Also detailed information on accessories, circuits and control.

**Refractories.** The Babcock & Wilcox Co., 85 Liberty St., New York City—Bulletin R-19—Leaflet describing this company's insulating "Concrete-Mix" in two grades for temperatures to 2,000 and 2,200 deg. F., respectively.

**Refractories.** The Mullite Refractories Co., Shelton, Conn.—50-page catalog on this company's Shamva Mullite refractories, with information on high-temperature applications to 3,300 deg. F. and complete discussion of properties of mullite refractories.

**Refrigeration.** Carrier Corp., Syracuse, N. Y.—Bulletin CR-137—4-page leaflet briefly explaining this company's centrifugal refrigeration equipment, listing typical uses and typical users and showing expansion of this method of refrigeration in recent years.

**Refrigeration.** Worthington Pump & Machinery Corp., Harrison, N. J.—Bulletin W-207-B1—8 pages on steam jet vacuum refrigeration units with information on construction, operation, specifications and engineering data.

**Safety Equipment.** Mine Safety Appliances Co., Braddock, Thomas & Meade Sts., Pittsburgh, Pa.—Publications as follows: Bulletin CE-10, 4 pages on a variety of welding helmets and accessory protective equipment; Bulletin BM-2, describes improved 1-hour oxygen breathing apparatus in both chest and back type models; Bulletin DW-1, leaflet describing this company's new automatic continuous oxygen recorder.

**Safety Tools.** Ampco Metal, Inc., 3830 West Burnham St., Milwaukee, Wis.—Catalog 116—20-page catalog and price list on this company's wide range of non-sparking safety tools made of Ampco metal and Ampco beryllium-copper.

**Speed Reducers.** Philadelphia Gear Works, Philadelphia, Pa.—64-page catalog covering this company's single, double and triple reduction herringbone speed reducing units in ranges up to 300 to 1 with descriptions and dimensional drawings.

**Stainless Design.** The Carpenter Steel Co., Reading, Pa.—8-page booklet for equipment designers, dealing with the characteristics of this company's stainless steel from a design standpoint.

**Steels.** The Babcock & Wilcox Tube Co., Beaver Falls, Pa.—Technical Bulletin 12-A—Gives condensed technical information on high-temperature steels with revised information and technical data on this company's seamless alloy tubes and pipe for high-pressure and high-temperature service.

**Valves.** J. E. Lonergan Co., 211 Race St., Philadelphia, Pa.—Supplementary Catalog 600—24-page catalog describing this company's pop safety and relief valves in numerous styles, together with engineering data tables; also describes pressure gages.

**Valves.** Parker Appliance Co., 17325 Euclid Ave., Cleveland, Ohio—Bulletin 38B—Loose-leaf catalog on this company's valves, in two sections: first section deals with complete descriptive data, dimensions and classifications on valves. Second section contains price lists in consolidated form. Complete classified index included.

**Valves and Fittings.** Crane Co., 836 South Michigan Ave., Chicago, Ill.—Circular 312—56-page book on corrosion resisting valves and fittings with information on types and sizes available in various corrosion resisting metals and alloys, information on the construction materials, and novel chart showing resistance of various materials to nearly 200 corrosive agents.

**Vibrating Equipment.** Ajax Flexible Coupling Co., Westfield, N. Y.—Publications as follows: Bulletin 28, 6 pages on Ajax vibrating screens; Bulletin 29, vibrating conveyors and feeders; Bulletin 30, vibrating packers for powdered material.

**Welding.** Lincoln Electric Co., Cleveland, Ohio.—Welder Specification Bulletins 308, 336—4-page bulletins covering respectively a 200-amp. Shield-Arc Junior welder with self-indicating dual continuous control; and a 200-amp. Shield-Arc Junior engine-driven model.

# *The NEW Electrolytic Process that*
# CLEANS, BRIGHTENS, POLISHES
## Corrosion Resisting – CASTINGS – Stainless Steel

**LUSTRACAST**
**by COOPER**

Trade Mark Registered U. S. Patent Office

- ***Reduces Mechanical Grinding, Polishing, Burnishing Costs.***
- ***Imparts Greater Brilliance, Depth of Finish, LONGER LIFE!***

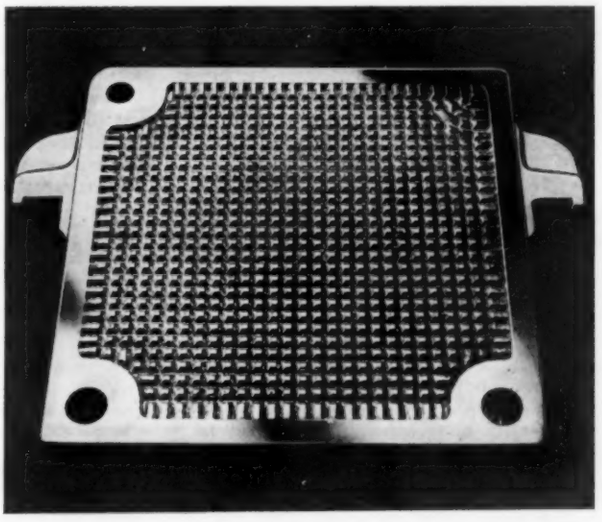
*Again* COOPER ALLOY leads the way in the production of corrosion-resisting alloy steel castings!

*Again* COOPER ALLOY pioneers in applying the latest in metallurgical advancement to the improvement of stainless steel castings!

LUSTRACAST finish, now available on COOPER alloy castings, gives a rich, brilliantly-lustrous sheen comparable to the finest mechanical polishes . . . but with greatly reduced polishing cost. LUSTRACAST improves machinability due to the uniform removal of scale. LUSTRACAST provides a smoother, cleaner, surface; lessens surface contamination, contact corrosion—prolongs life. LUSTRACAST cleans and brightens odd-size, odd-shaped castings formerly impossible or impractical to polish.

Increase the saleability of your product! Specify LUSTRACAST finish on your next casting order.

An illustrated descriptive folder will be mailed on request. Write *today* for your copy and a FREE casting sample LUSTRACAST.



*LUSTRACAST . . . . 18-8 Stainless Steel Filter Press Plate. Courtesy of T. SHRIVER & CO., Harrison, N. J.*

## *The* COOPER ALLOY FOUNDRY CO.

*Specialists in Casting Alloy Steels Exclusively.*

ALLOY CASTING RESEARCH INSTITUTE MEMBER

**ELIZABETH • NEW JERSEY**

# Chemical ECONOMICS and MARKETS

## CONSUMPTION OF CHEMICALS GAINED 22 PER CENT IN VOLUME LAST YEAR

WHILE some consuming industries ran counter to seasonal trends in December, others followed a more normal course and as a result there was a decline in the disappearance of chemicals and related materials. From incomplete data the preliminary index for consumption of chemicals approximates 137 which compares with 142.89 for November and with 113.71 for December 1938. For the twelve-month period, the indexes indicate an increase of about 22 per cent in consumption of chemicals in 1939 over 1938 and only 6 per cent under the level reached in 1937.

For the first quarter of last year, the index averaged 114.87. A 20 per cent gain for the first quarter of this year would result in an average index of 137.84. In view of the present outlook for iron and steel, textiles, automobiles, rubber, pulp and paper, rayon, plastics, and glass, an increase of this extent is not improbable.

*Chem. & Met.* Index for Consumption of Chemicals

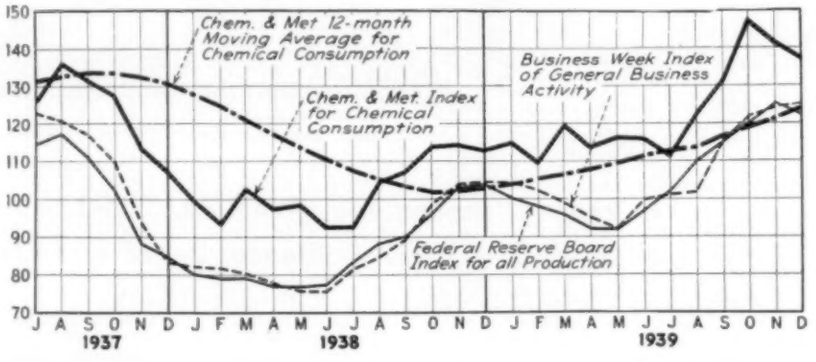
| | October Revised | November |
|---|---|---|
| Fertilizer | 31.55 | 32.81 |
| Pulp and paper | 19.82 | 18.63 |
| Glass | 14.93 | 12.04 |
| Petroleum refining | 14.48 | 13.75 |
| Paint and varnish | 11.63 | 9.89 |
| Iron and steel | 11.70 | 11.82 |
| Rayon | 10.62 | 11.08 |
| Textiles | 8.96 | 9.07 |
| Coal products | 8.63 | 8.91 |
| Leather, glue and gelatine | 4.40 | 3.88 |
| Explosives | 5.93 | 5.18 |
| Rubber | 3.42 | 3.33 |
| Plastics | 2.44 | 2.50 |
| | 148.51 | 142.89 |

Activities in December were highlighted by the high rate maintained at steel plants up to the final week of the year. Moderate declines in manufacturing operations were reported in petroleum refining, textiles—although silk consumption fell sharply—leather, and rubber. Pulp mills operated actively but there was curtailment at paperboard plants. Some divisions of glass manufacture held up well but the industry as a whole was affected by smaller outputs from the important container branch.

The Shippers Advisory Boards in estimating freight car requirements for the first quarter, place the increase in freight movement at 12.1 per cent over actual movement in the Jan.-March period of 1938. Percentage increases for some of the separate groups are: chemicals and explosives, 10.4; fertilizer, 5.4; paper and products, 15.6; automobiles, 18.8; and iron and steel, 45.3.

Larger consumption of chemicals in the present quarter as compared with last year is foreshadowed not only by the improved status of business in general but also because of additional plant capacities which will be in operation. For instance, production of some chemicals now exists where a year ago such products were entirely of foreign origin. A new sulphite pulp mill in Florida made its first deliveries this month and will be able to reduce demand for foreign-made pulp. Rayon plant capacity is larger than it was a year ago and this is especially true for output of staple. All these developments are conducive to enlarged domestic consumption of chemicals.

The report prepared monthly by the Bureau of the Census in cooperation with the National Association of Credit Men, shows that sales of manufacturers in November were 21 per cent above those reported for November 1938. Sales of chemicals and allied products were 24.2 per cent higher than in the 1938 month but were down 11.4 per cent from the October total. For some of the other groups, percentage changes from October and from November 1938 were: paint and varnish, down 20.4 and up 11.1; textiles down 14.8 and up 23.3; paper down 10.1 and up 36.7; leather and products down 20.7 and up 11.4; stone, clay and glass products down 17.9 and up 27.7.


Chem. & Met 12-month Moving Average for Chemical Consumption
Business Week Index of General Business Activity
Chem. & Met. Index for Chemical Consumption
Federal Reserve Board Index for all Production
150
140
130
120
110
100
90
80
70
J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1937
1938
1939

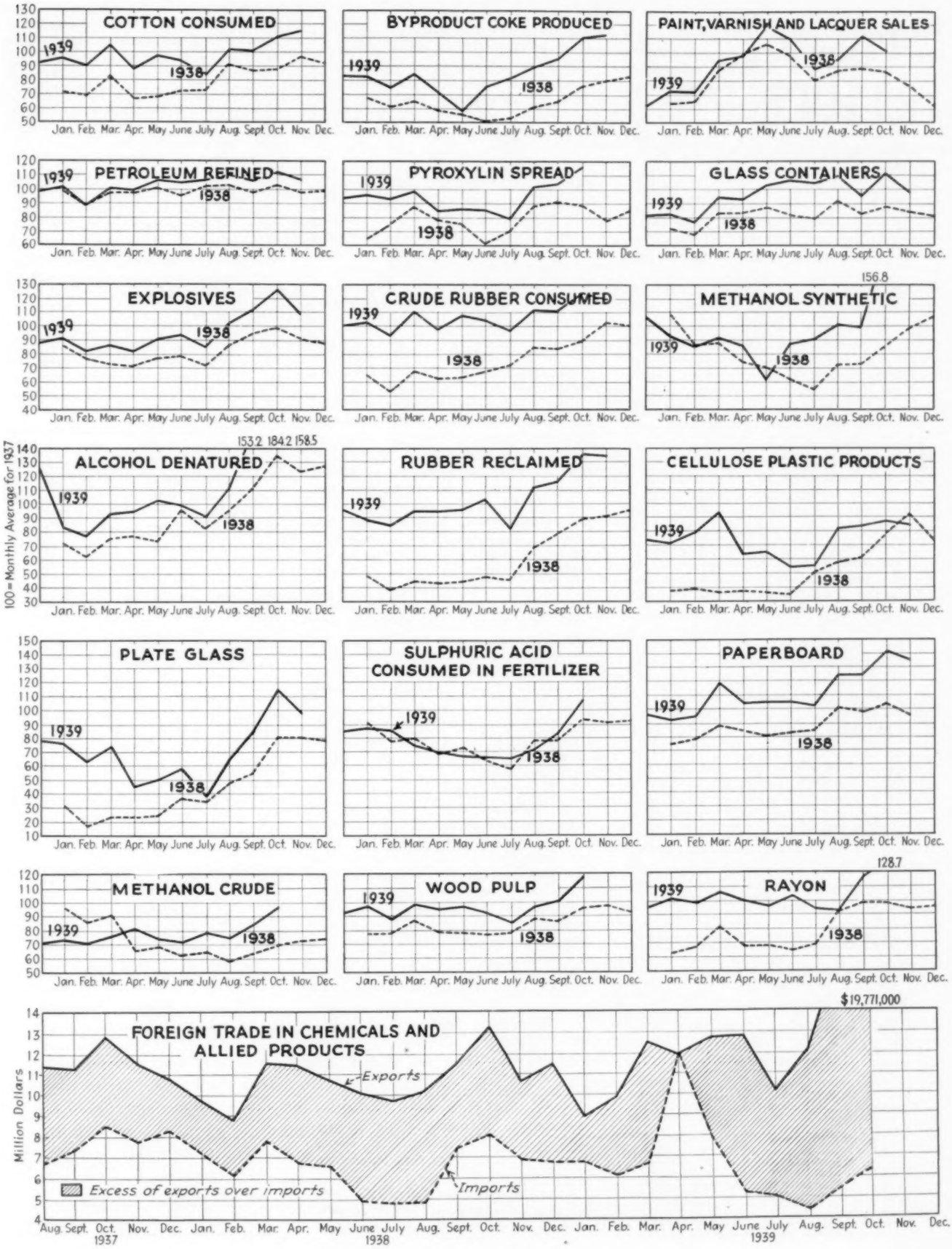
Exports of chemicals and related products continued at high levels during November 1939, aggregating $19,321,000 as compared with shipments valued at $12,612,500 during the corresponding month of 1938. The November figure was well above average, but was about $5,000,000 below the $24,594,000 total reached in October, when a new all-time high record was established.

Production and Consumption Data for Chemical-Consuming Industries

| | November 1939 | November 1938 | January-November 1939 | January-November 1938 | Per cent of gain for 1939 |
|---|---|---|---|---|---|
| **Production** | | | | | |
| Alcohol, ethyl, 1,000 pr. gal | 21,787 | 15,164 | 199,530 | 175,979 | 13.4 |
| Alcohol denatured, 1,000 wi. gal | 13,060 | 10,186 | 102,757 | 82,424 | 24.7 |
| Ammonia, liquor, 1,000 lb | 4,862 | 3,794 | 43,310 | 36,422 | 18.9 |
| Ammonium sulphate, tons | 59,745 | 44,985 | 518,083 | 390,866 | 32.5 |
| Benzol, 1,000 gal | 11,230 | 7,619 | 90,934 | 63,560 | 43.1 |
| Byproduct coke, 1,000 tons | 4,567 | 3,278 | 38,313 | 28,433 | 34.7 |
| Glass containers, 1,000 gr. | 4,300 | 3,709 | 47,180 | 39,589 | 19.1 |
| Plate glass, 1,000 sq. ft | 15,812 | 12,882 | 123,264 | 73,035 | 68.8 |
| Nitrocellulose plastics, 1,000 lb. | 1,361 | 1,018 | 12,284 | 8,699 | 41.2 |
| Cellulose acetate plastics, 1,000 lb. | | | | | |
| Sheets, rods, and tubes | 725 | 1,332 | 8,154 | 5,719 | 42.6 |
| Molding material | 1,199 | 1,031 | 10,472 | 6,636 | 57.8 |
| Rubber reclaimed, tons | 20,755 | 13,995 | 175,994 | 120,758 | 45.7 |
| Steel barrels, light, 1,000 | 295 | 170 | 2,322 | 1,818 | 27.7 |
| Steel barrels, heavy, 1,000 | 1,575 | 788 | 10,292 | 7,726 | 33.2 |
| Superphosphate, bulk, tons | 417,410 | 326,794 | 3,395,995 | 3,232,384 | 5.1 |
| **Consumption** | | | | | |
| Cotton, bales | 718,721 | 596,416 | 6,718,725 | 5,338,074 | 25.9 |
| Silk, bales | 32,241 | 41,599 | 362,303 | 376,590 | 3.9* |
| Wool, 1,000 lb | 35,614 | 31,228 | 366,304 | 245,318 | 49.3 |
| Explosives, 1,000 lb | 35,477 | 29,385 | 341,891 | 291,874 | 17.1 |
| Rubber, crude, tons | 54,322 | 49,050 | 529,163 | 379,034 | 39.6 |
| Waste paper, tons | 339,335 | 243,924 | 3,155,707 | 2,566,303 | 23.0 |

* Per cent of decrease.

# Production and Consumption Trends



## DELIVERIES OF CHEMICALS GAIN HEADWAY AFTER BRIEF INVENTORY-TAKING PERIOD

PRODUCERS of chemicals entered the new year with the greater part of their consuming clientele covered by contract commitments. Small-lot buyers in recent years have found it desirable to cover requirements ahead and this trend still continues which has the effect of reducing trading in the spot market. Recent spot inquiries have been concerned mainly with selections which are in limited supply and resale lots continue to change hands at prices higher than the open quotations for round lots.

Some of the large consuming companies have gone through an inventory-taking period but as the month progressed manufacturing operations again resumed on a high plane and shipping instructions gained in volume so that the tonnage movement made a very favorable showing as compared with that for the corresponding period of last year.

A firm tone underlies prices with the market apparently free from sales pressure. In a few instances exceptions are found as in the case of casein for which prices have eased for the domestic product. Up to September, imports of casein had been relatively light but the active demand which sprang up from September on brought sharp advances in quotations and this in turn, centered interest on the imported material. In the closing months of the year there was a marked upturn in importations from the Argentine and while prices for domestic casein have been slightly lowered, they still are above the parity of those quoted in Argentine markets and indications point to continued heavy imports.

Contract prices for chlorate of potash have been named at advanced levels with home-made material making up for the loss resulting from the restricted movement from abroad. Quicksilver has been marked up in foreign distribution centers and this has had a corresponding effect in domestic markets with consuming requirements said to be incompletely filled. Strong markets have ruled for acids, potash salts, alums, copperas, and bichromates. Salt cake has been quoted at different levels depending on point of delivery with some sellers reported to be restricting sales within given freight zones. Only scattered lots of imported salt cake have reached domestic markets.

The collapse of negotiations looking toward a trade agreement with the Argentine has relieved some apprehension on the part of the domestic casein industry. Attempts to develop a domestic production of casein have been predicated upon a tariff high enough to enable producers to compete with the imported material. At present stocks of domestic casein are low and there is necessity of importing but given a good consuming market and a compensating price level, domestic manufacture might be established on a basis which would be sufficient for consuming requirements but a drop in import duty would make this improbable.

Over a long period it has been customary to import large amounts of linseed from the Argentine. This has been rendered necessary because the home output has not been large enough to supply crushing needs. Considerable time and money have been expended in order to influence growers to increase their flax acreage. These measures have met with more success this season than in earlier years and the flaxseed crop in the Northwest is larger than it has been in many years. Consequently, a lowering in import tariff would affect farmers more adversely this year than usual. Furthermore, the movement to grow flax outside the northwestern states has been making headway. California has been assuming importance as a flax-growing state and there is the possibility that Texas may follow suit but this incentive would be lost if the present protection were to be removed or markedly reduced.

A larger movement into foreign trade is predicted for naval stores and the market for both turpentine and rosin has been firmer in the last month. The most important development was found in the announcement that the program of the Commodity Credit Corporation had been approved for 1940. Loans will be made to producers who have subscribed to the conservation program. Basic loan values are established at 23 cents a gallon on turpentine in bulk and $5.15 per 280-lb. barrel on grade H rosin with differentials for other grades. Loans will not be made on turpentine in barrels or on rosins below G grade.

Incidentally it is worthy of note that Great Britain plans to add materially to its foreign trade outside of the Dominions. Recent issues of the Economist of London have stressed the point that the Government must use its resources to extend exports. Excerpts from that publication read as follows:

"It is therefore clear that a sales campaign in Latin America must in the first instance be directed to the recapture of orders for the products of our heavy industries, particularly iron and steel and machinery. We should certainly be able to supply the extra demand for coal from Brazil and the Argentine, but we shall have to face strong competition from the U.S.A. in any bid for the trade in iron and steel, machinery and railway equipment. But if we cannot recapture trade here, we cannot recapture it anywhere."

"In the Argentine we enjoy preferential treatment, we have established channels of trade and we are likely to maintain, if not increase, our purchases of Argentine meat and cereals."

"The gap in imports caused by the cessation of trade with Germany is largest in Brazil and Chile, and these should be *prima facie* the most promising cases for a British campaign. * * * The Chilean and Brazilian markets offer considerable opportunities, but in them we shall have to face much stronger competition from the U.S.A. than in the Argentine or Uruguay."

"This very brief survey of the possibilities in the South American market sharply illumines the futility of supposing that the British exporter can be expected to seize the opportunities of his own initiative."

"The individual problems are doubtless different elsewhere from what they have been shown to be in this one market. But their nature has at least this much in common—that they can only be solved by Government action. British exports to South America will flourish only if there is an elastic exchange policy, a decision to allocate materials for the purpose, and to see that they are used, a price policy that does not expect South Americans to bear the costs of our armament programme, a shipping service not noticeably inferior to that with the United States. None of these things are within the reach of the individual exporter, or of the export industries organized in trade associations, or of a junior and neglected department of State. They are attainable only by an exercise of organizing initiative on the part of the War Cabinet itself."

"The task will, doubtless, be difficult and costly. But the alternative is still further decay in our export industries and impairment of that ability to call on the resources of the whole world on which our ability to win the war unconditionally depends."

### CHEM. & MET.

**Weighted Index of**

### CHEMICAL PRICES

Base = 100 for 1937

| | |
|---|---|
| **This month** | **98.72** |
| Last month | 98.86 |
| January, 1939 | 98.88 |
| January, 1938 | 100.84 |

While the market as a whole appears to be in a strong position, there were downward revisions in the last month and the index was lowered. Among the important changes was a lower sales schedule for lithopone.

### CHEM. & MET.

**Weighted Index of Prices for**

### OILS AND FATS

Base = 100 for 1937

| | |
|---|---|
| **This month** | **82.59** |
| Last month | 78.25 |
| January, 1939 | 75.64 |
| January, 1938 | 78.05 |

Vegetable oils generally, were marked up with crude cottonseed, linseed, soy and corn oils leading in the price movement. China wood is strongly held with irregular shipments from primary points.

# Current PRICES

## INDUSTRIAL CHEMICALS

| | Current Price | Last Month | Last Year |
|---|---|---|---|
| Acetone, drums, lb | $0.07½-$0.07¾ | $0.07 -$0.07½ | $0.05½-$0.06½ |
| Acid, acetic, 28%, bbl., cwt | 2.23 - 2.48 | 2.23 - 2.48 | 2.23 - 2.48 |
| Glacial 99%, drums | 8.43 - 8.68 | 8.43 - 8.68 | 8.43 - 8.68 |
| U. S. P. reagent | 10.25 -10.50 | 10.25 -10.50 | 10.25 -10.50 |
| Boric, bbl., ton | 106.00-111.00 | 106.00-111.00 | 106.00-111.00 |
| Citric, kegs, lb | .20 - .23 | .20 - .23 | .23½- .26 |
| Formic, bbl., ton | .10½- .11 | .10½- .11 | .10½- .11 |
| Gallic, tech., bbl., lb | .70 - .75 | .70 - .75 | .70 - .75 |
| Hydrofluoric 30% carb., lb | .07 - .07½ | .07 - .07½ | .07 - .07½ |
| Lactic, 44%, tech., light, bbl., lb | .06½- .06¾ | .06½- .06¾ | .06½- .06¾ |
| Muriatic, 18°, tanks, cwt | 1.05 -..... | 1.05 -..... | 1.05 -..... |
| Nitric, 36°, carboys, lb | .05 - .05½ | .05 - .05½ | .05 - .05½ |
| Oleum, tanks, wks., ton | 18.50 -20.00 | 18.50 -..... | 18.50 -20.00 |
| Oxalic, crystals, bbl., lb | .10¾- .12 | .10¾- .12 | .10¾- .12 |
| Phosphoric, tech., c'bys., lb | .07½- .08½ | .07½- .08½ | .07½- .08½ |
| Sulphuric, 60° tanks, ton | 13.00 -..... | 13.00 -..... | 13.00 -..... |
| Sulphuric, 66°, tanks, ton | 16.50 -..... | 16.50 -..... | 16.50 -..... |
| Tannic, tech., bbl., lb | .40 - .45 | .40 - .45 | .40 - .45 |
| Tartaric, powd., bbl., lb | .31½-..... | .31½-..... | .27½-..... |
| Tungstic, bbl., lb | nom..... | 2.35 -..... | 2.75 -..... |
| Alcohol, Amyl | ....- | ....- | ....- |
| From Pentane, tanks, lb | .101-..... | .101-..... | .106-..... |
| Alcohol, Butyl, tanks, lb | .09 -..... | .09 -..... | .08½-..... |
| Alcohol, Ethyl, 190 p'f., bbl., gal | 4.54 -..... | 4.54 -..... | 4.58½-..... |
| Denatured, 190 proof | ....- | ....- | ....- |
| No. 1 special, bbl., gal. wks | .29½-..... | .29½-..... | .30 -..... |
| Alum, ammonia, lump, bbl., lb | .03½- .04 | .03½- .04 | .03½- .04 |
| Potash, lump, bbl., lb | .03½- .04 | .03½- .04 | .03½- .04 |
| Aluminum sulphate, com. bags, cwt | 1.15 - 1.40 | 1.15 - 1.40 | 1.15 - 1.40 |
| Iron free, bg., cwt | 1.30 - 1.55 | 1.30 - 1.55 | 1.30 - 1.55 |
| Aqua ammonia, 26°, drums, lb | .02½- .03 | .02 - .03 | .02½- .03 |
| tanks, lb | .02 - .02½ | .02 - .02½ | .02½- .02¾ |
| Ammonia, anhydrous, cyl., lb | .16 -..... | .16 -..... | .15½-.16 |
| tanks, lb | .04½-..... | .04½-..... | .04½-.16 |
| Ammonium carbonate, powd. tech., casks, lb | .09 - .12 | .09 - .12 | .08 - .12 |
| Sulphate, wks, cwt | 1.40 -..... | 1.40 -..... | 1.3875-..... |
| Amylacetate tech., tanks, lb | .10½-..... | .10½-..... | .09½-..... |
| Antimony Oxide, bbl., lb | nom ..... | nom..... | .11½- .12 |
| Arsenic, white, powd., bbl., lb | .03 - .03½ | .03 - .03½ | .03 - .03½ |
| Red, powd., kegs, lb | .15½- .16 | .15½- .16 | .15½- .16 |
| Barium carbonate, bbl., ton | 52.50 -57.50 | 52.50 -57.50 | 52.50 -57.50 |
| Chloride, bbl., ton | 79.00 -81.00 | 79.00 -81.00 | 79.00 -81.00 |
| Nitrate, casks, lb | .07 - .08 | .07 - .08 | .07 - .08 |
| Blanc fixe, dry, bbl., lb | .03½- .04 | .03½- .04 | .03½- .04 |
| Bleaching powder, f. o. b., wks., drums, cwt | 2.00 - 2.10 | 2.00 - 2.10 | 2.00 - 2.10 |
| Borax, gran., bags, ton | 48.00 -51.00 | 48.00 -51.00 | 48.00 -51.00 |
| Bromine, cs., lb | .30 - .32 | .30 - .32 | .30 - .32 |
| Calcium acetate, bags | 1.90 -..... | 1.90 -..... | 1.65 - 1.75 |
| Arsenate, dr., lb | .06½- .07 | .06½- .07 | .06½- .07 |
| Carbide drums, lb | .04½- .05 | .05 - .06 | .05 - .06 |
| Chloride, fused, dr., del., ton | 21.50 -24.50 | 21.50 -24.50 | 21.50 -24.50 |
| flake, dr., del., ton | 23.00 -25.00 | 23.00 -25.00 | 23.00 -25.00 |
| Phosphate, bbl., lb | .07½- .08 | .07½- .08 | .07½- .08 |
| Carbon bisulphide, drums, lb | .05 - .06 | .05 - .06 | .05 - .06 |
| Tetrachloride drums, lb | .04½- .05½ | .04½- .05½ | .05½- .06 |
| Chlorine, liquid, tanks, wks., lb | 1.75 -..... | 1.75 -..... | 2.00 -..... |
| Cylinders | .05½- .06 | .05½- .06 | .05½- .06 |
| Cobalt oxide, cans, lb | 1.84 - 1.87 | 1.84 - 1.87 | 1.67 - 1.70 |
| Copperas, bgs., f. o. b., wks., ton | 17.00 -18.00 | 15.00 -16.00 | 15.00 -16.00 |
| Copper carbonate, bbl., lb | .10 - .16½ | .10 - .16½ | .10 - .16 |
| Sulphate, bbl., cwt | 4.75 - 5.00 | 4.75 - 5.00 | 4.50 - 4.75 |
| Cream of tartar, bbl., lb | .25½-..... | .25½-..... | .22½-..... |
| Diethylene glycol, dr., lb | .22 - .23 | .22 - .23 | .22 - .23 |
| Epsom salt, dom., tech., bbl., cwt | 1.80 - 2.00 | 1.80 - 2.00 | 1.80 - 2.00 |
| Ethyl acetate, drums, lb | .06½-..... | .061-..... | .06½-..... |
| Formaldehyde, 40%, bbl., lb | .05½- .06½ | .05½- .06½ | .05½- .6½ |
| Furfural, tanks, lb | .09 -..... | .09 -..... | .09 -..... |
| Fusel oil, ref. drums, lb | .16 - .17 | .16 - .17 | .12½- .14 |
| Glaubers salt, bags, cwt | .95 - 1.00 | .95 - 1.00 | .95 - 1.00 |
| Glycerine, c.p., drums, extra, lb | .12½-..... | .12½-..... | .12½-..... |
| Lead: | | | |
| White, basic carbonate, dry casks, lb | .07 -..... | .07 -..... | .07 -..... |
| White, basic sulphate, sck., lb | .06½-..... | .06½-..... | .06½-..... |
| Red, dry, sck., lb | .08 - ..... | .08 - ..... | .0735..... |
| Lead acetate, white crys., bbl., lb | .11 - .12 | .11 - .12 | .10 - .11 |
| Lead arsenate, powd., bbl., lb | .10 - .10½ | .10 - .10½ | .11 - .11½ |
| Lime, chem., bulk, ton | 8.50 -..... | 8.50 -..... | 8.50 -..... |
| Litharge, pwd., csk., lb | .07 -..... | .07 -..... | .0635..... |
| Lithophone, bags, lb | .036- .04 | .04 - .04½ | .04½- .05 |
| Magnesium carb., tech., bags, lb | .06½- .06¾ | .06 - .06½ | .06 - .06½ |

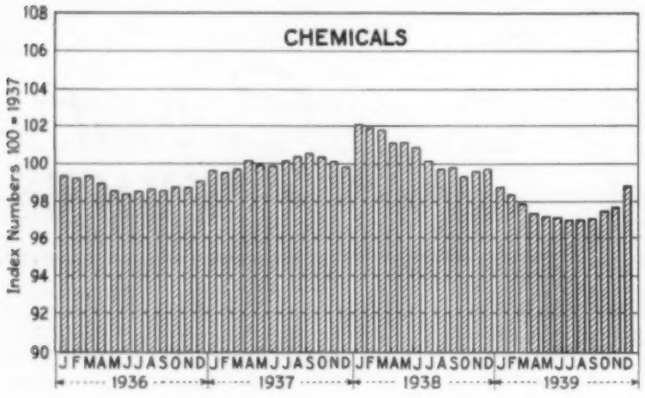
| | Current Price | Last Month | Last Year |
|---|---|---|---|
| Methanol, 95%, tanks, gal | .31 -..... | .31 -..... | .31 -..... |
| 97%, tanks, gal | .32 -..... | .32 -..... | .32 -..... |
| Synthetic, tanks, gal | .33 -..... | .33 -..... | .33 -..... |
| Nickel salt, double, bbl., lb | .13 - .13½ | .13 - .13½ | .13 - .13½ |
| Orange mineral, csk., lb | .10½-..... | .10½-..... | .10½-..... |
| Phosphorus, red, cases, lb | .40 - .42 | .40 - .42 | .40 - .42 |
| Yellow, cases, lb | .18 - .25 | .18 - .25 | .24 - .30 |
| Potassium bichromate, casks, lb | .08½- .09 | .08½- .09 | .08½- .09 |
| Carbonate, 80-85%, calc. csk., lb | .06½- .07 | .06½- .07 | .06½- .07 |
| Chlorate, powd., lb | .10-.12.... | nom. ..... | .09½-..... |
| Hydroxide (c'stic potash) dr., lb | .07 - .07½ | .07 - .07½ | .07 - .07½ |
| Muriate, 80% bgs., unit | .53½-..... | .53½-..... | .53½-..... |
| Nitrate, bbl., lb | .05½- .06 | .05½- .06 | .05½- .06 |
| Permanganate, drums, lb | .18½- .19 | .18½- .19 | .18½- .19 |
| Prussiate, yellow, caks, lb | .15 - .16 | .15 - .16 | .15 - .16 |
| Sal ammoniac, white, casks, lb | .05½- .06 | .05½- .06 | .05 - .05½ |
| Salsoda, bbl., cwt | 1.00 - 1.05 | 1.00 - 1.05 | 1.00 - 1.05 |
| Salt cake, bulk, ton | 13.00 -..... | 13.00 -15.00 | 13.00 -15.00 |
| Soda ash, light, 58%, bags, contract, cwt | 1.05 -..... | 1.05 -..... | 1.05 -..... |
| Dense, bags, cwt | 1.10 -..... | 1.10 -..... | 1.10 -..... |
| Soda, caustic, 76%, solid, drums, cwt | 2.30 - 3.00 | 2.30 - 3.00 | 2.30 - 3.00 |
| Acetate, works, bbl., lb | .04 - .05 | .04 - .05 | .04½- .05 |
| Bicarbonate, bbl., cwt | 1.70 - 2.00 | 1.70 - 2.00 | 1.75 - 2.00 |
| Bichromate, casks, lb | .06½- .07 | .06½- .07 | .06½- .07 |
| Bisulphate, bulk, ton | 15.00 -16.00 | 15.00 -16.00 | 15.00 -16.00 |
| Bisulphite, bbl., lb | .03½- .04 | .03½- .04 | .03½- .04 |
| Chlorate, kegs, lb | .06½- .06¾ | .06½- .06¾ | .06½- .06¾ |
| Cyanide, cases, dom., lb | .14 - .15 | .14 - .15 | .14 - .15 |
| Fluoride, bbl., lb | .07½- .08 | .07½- .08 | .07½- .08 |
| Hyposulphite, bbl., cwt | 2.40 - 2.50 | 2.40 - 2.50 | 2.40 - 2.50 |
| Metasilicate, bbl., cwt | 2.20 - 3.20 | 2.20 - 3.20 | 2.20 - 3.20 |
| Nitrate, bulk, cwt | 1.45 -..... | 1.35 -..... | 1.45 -..... |
| Nitrite, casks, lb | .06½- .07 | .06½- .07 | .07 - .08 |
| Phosphate, tribasic, bags, lb | 2.25 -..... | 2.25 -..... | 1.85 -..... |
| Prussiate, yel. drums, lb | .10½- .11 | .10½- .11 | .09½- .10 |
| Silicate (40° dr.) wks., cwt | .80 - .85 | .80 - .85 | .80 - .85 |
| Sulphide, fused, 60-62%, dr., lb | .02½- .03½ | .02½- .03 | .02½- .03 |
| Sulphite, crys., bbl., lb | .02½- .02½ | .02½- .02½ | .02½- .02½ |
| Sulphur, crude at mine, bulk, ton | 16.00 -..... | 16.00 -..... | 18.00 -..... |
| Chloride, dr., lb | .03 - .04 | .03 - .04 | .03 - .04 |
| Dioxide, cyl., lb | .07 - .08 | .07 - .08 | .07 - .07½ |
| Flour, bag, cwt | 1.60 - 3.00 | 1.60 - 3.00 | 1.60 - 3.00 |
| Tin Oxide, bbl., lb | .52 -..... | .52 -..... | .36½-..... |
| Crystals, bbl., lb | .37 -..... | .40 -..... | .36 -..... |
| Zinc, chloride, gran., bbl., lb | .05 - .06 | .05 - .06 | .05 - .06 |
| Carbonate, bbl., lb | .14 - .15 | .14 - .15 | .14 - .15 |
| Cyanide, dr., lb | .33 - .35 | .33 - .35 | .33 - .35 |
| Dust, bbl., lb | .07½-..... | .08½-..... | .06½-..... |
| Zinc oxide, lead free, bag., lb | .06½-..... | .06½-..... | .06½-..... |
| 5% lead sulphate, bags, lb | .06½-..... | .06½-..... | .06½-..... |
| Sulphate, bbl., cwt | 2.75 - 3.00 | 2.75 - 3.00 | 3.15 - 3.60 |

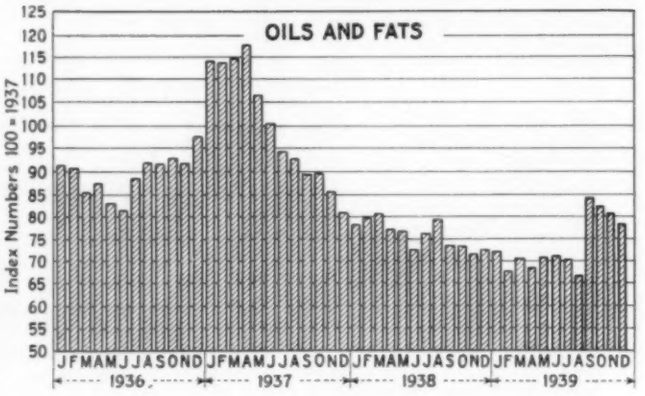
## OILS AND FATS

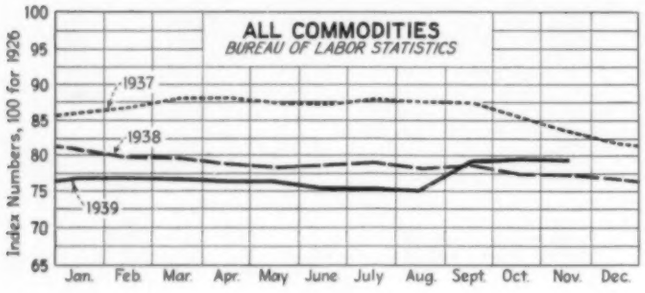
| | Current Price | Last Month | Last Year |
|---|---|---|---|
| Castor oil, 3 bbl., lb | $0.11½-$0.12 | $0.11½-$0.12 | $0.09½-$0.10 |
| Chinawood oil, bbl., lb | .27 -..... | .26 -..... | .15½-..... |
| Coconut oil, Ceylon, tank, N. Y., lb | .03½-..... | .03¾-..... | .03 -..... |
| Corn oil crude, tanks (f. o. b. mill), lb | .06 -..... | 05¾-..... | .06½-..... |
| Cottonseed oil, crude (f. o. b. mill), tanks, lb | .05½-..... | .05¾-..... | .06 -..... |
| Linseed oil, raw car lots, bbl., lb | .108-..... | .097-..... | .085-..... |
| Palm, casks, lb | .05½-..... | .05½-..... | .036-..... |
| Peanut oil, crude, tanks (mill), lb | .06½-..... | 06½-..... | .06½-..... |
| Rapeseed oil, refined, bbl., gal | 1.00 -..... | 1.00 -..... | .80 -..... |
| Soya bean, tank, lb | .05¾-..... | .04¾-..... | .05½-..... |
| Sulphur (olive foots), bbl., lb | .08½-..... | .10 -..... | .07 -..... |
| Cod, Newfoundland, bbl., gal | nom..... | nom. ..... | .38 -..... |
| Menhaden, light pressed, bbl., lb | .073-..... | 069-..... | .071-..... |
| Crude, tanks (f. o. b. factory), gal | .36 -..... | .35 -..... | .32 -..... |
| Grease, yellow, loose, lb | .05 -..... | .05 -..... | .04½-..... |
| Oleo stearine, lb | .06½-..... | .08½-..... | .06¾-..... |
| Oleo oil, No. 1 | .07½-..... | .08 -..... | .08½-..... |
| Red oil, distilled, d.p. bbl., lb | .09 -..... | .09 -..... | .07½-..... |
| Tallow extra, loose, lb | .05½-..... | .05½-..... | .05½-..... |

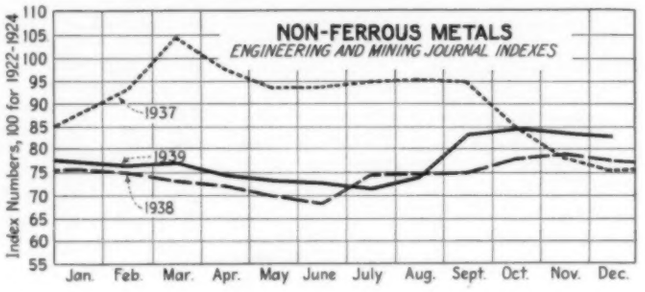
The accompanying prices refer to round lots in the New York market. Where it is the trade custom to sell f.o.b. works, quotations are given on that basis and are so designated. Prices are corrected to Jan. 13

# Chem. & Met.'s Weighted Price Indexes




## COAL-TAR PRODUCTS

| | Current Price | Last Month | Last Year |
|---|---|---|---|
| Alpha-napthol, crude bbl., lb. | $0.52 -$0.55 | $0.52 -$0.55 | $0.52 -$0.55 |
| Alpha-naphthylamine, bbl., lb. | .32 - .34 | .32 - .34 | .32 - .34 |
| Aniline oil, drums, extra, lb. | .15 - .16 | .15 - .16 | .15 - .16 |
| Aniline, salts, bbl., lb. | .22 - .24 | .22 - .24 | .22 - .24 |
| Benzaldehyde, U.S.P., dr., lb. | .85 - .95 | .85 - .95 | .85 - .95 |
| Benzidine base, bbl., lb. | .70 - .75 | .70 - .75 | .70 - .75 |
| Benzoic acid, U.S.P., kgs., lb. | .54 - .56 | .54 - .56 | .54 - .56 |
| Benzyl chloride, tech., dr., lb. | .23 - .25 | .23 - .25 | .23 - .25 |
| Benzol, 90%, tanks, works, gal. | .16 -..... | .16 - .18 | .16 - .18 |
| Beta-napthol, tech., drums, lb. | .23 - .24 | .23 - .24 | .23 - .24 |
| Cresol, U.S.P., dr., lb. | .09½- .10 | .09½- .10 | .10 - .11 |
| Cresylic acid, dr., wks., gal. | .58 - .60 | .58 - .60 | .69 - .71 |
| Diethylaniline, dr., lb. | .40 - .45 | .40 - .45 | .40 - .45 |
| Dinitrophenol, bbl., lb. | .23 - .25 | .23 - .25 | .23 - .25 |
| Dinitrotoluen, bbl., lb. | .15½- .16 | .15½- .16 | .15 - .16 |
| Dip oil, 15%, dr., gal. | .23 - .25 | .23 - .25 | .23 - .25 |
| Diphenylamine, bbl., lb. | .32 - .36 | .32 - .36 | .32 - .36 |
| H-acid, bbl., lb. | .50 - .55 | .50 - .55 | .50 - .55 |
| Naphthalene, flake, bbl., lb. | .06½- .07 | .05½- .06 | .05½- .06 |
| Nitrobensene, dr., lb. | .08 - .09 | .08 - .09 | .08 - .09 |
| Para-nitraniline, bbl., lb. | .47 - .49 | .47 - .49 | .47 - .49 |
| Phenol, U.S.P., drums, lb. | .13 -..... | .13 -..... | .14½-..... |
| Picric acid, bbl., lb. | .35 - .40 | .35 - .40 | .35 - .40 |
| Pyridine, dr., gal. | 1.70 - 1.80 | 1.70 - 1.80 | 1.55 - 1.60 |
| Resorcinal, tech., kegs, lb. | .75 - .80 | .75 - .80 | .75 - .80 |
| Salicylic acid, tech., bbl., lb. | .33 - .40 | .33 - .40 | .33 - .40 |
| Solvent naptha, w.w., tanks, gal. | .27 -..... | .27 -..... | .26 -..... |
| Tolidine, bbl., lb. | .86 - .88 | .86 - .88 | .86 - .88 |
| Toluene, drums, works, gal. | .30 -..... | .30 -..... | .27 -..... |
| Xylene, com, tanks, gal. | .27 -..... | .27 -..... | .26 -..... |

## MISCELLANEOUS

| | Current Price | Last Month | Last Year |
|---|---|---|---|
| Barytes, grd., white, bbl., ton. | $22.00-$25.00 | $22.00-$25.00 | $22.00-$25.00 |
| Casein, tech., bbl., lb. | .13 - .17 | .17 - .22 | .08½- .11 |
| China clay, dom., f.o.b. mine, ton. | 8.00 -20.00 | 8.00 -20.00 | 8.00 -20.00 |
| Dry colors | | | |
| Carbon gas, black (wks.), lb. | .02½- .30 | .02½- .30 | .02½- .30 |
| Prussian blue, bbl., lb. | .36 - .37 | .36 - .37 | .36 - .37 |
| Ultramarine blue, bbl., lb. | .11 - .26 | .11 - .26 | .10 - .26 |
| Chrome green, bbl., lb. | .21½- .30 | .21½- .30 | .21 - .27 |
| Carmine red, tins, lb. | 4.85 - 5.00 | 4.85 - 5.00 | 4.00 - 4.40 |
| Para toner, lb. | .75 - .80 | .75 - .80 | .75 - .80 |
| Vermilion, English, bbl., lb. | 2.45 - 2.60 | 2.45 - 2.60 | 1.50 - 1.55 |
| Chrome yellow, C.P., bbl., lb. | .14½- .15½ | .14½- .15½ | .14½- .15½ |
| Feldspar, No. 1 (f.o.b. N.C.), ton. | 6.50 - 7.50 | 6.50 - 7.50 | 6.50 - 7.50 |
| Graphite, Ceylon, lump, bbl., lb. | .06 - .06½ | .06 - .06½ | .06 - .06½ |
| Gum copal Congo, bags, lb. | .08 - .30 | .07 - .30 | .06 - .30 |
| Manila, bags, lb. | .09 - .15 | .08 - .14 | .09 - .14 |
| Damar, Batavia, cases, lb. | .10 - .22 | .08 - .20 | .08 - .24 |
| Kauri cases, lb. | .18 - .60 | .18 - .60 | .18½- .60 |
| Kieselguhr (f.o.b. N. Y.), ton. | 50.00 -55.00 | 50.00 -55.00 | 50.00 -55.00 |
| Magnesite, calc, ton. | 50.00 -..... | 50.00 -..... | 50.00 -..... |
| Pumice stone, lump, bbl., lb. | .05 - .07 | .05 - .08 | .05 - .07 |
| Imported, casks, lb. | .03 - .04 | .03 - .04 | .03 - .04 |
| Rosin, H., bbl. | 6.75 -..... | 6.75 -..... | 6.10 -..... |
| Turpentine, gal. | .34½-..... | .32½-..... | .30 -..... |
| Shellac, orange, fine, bags, lb. | .32 -..... | .27 -..... | .20 -..... |
| Bleached, bonedry, bags, lb. | .25 -..... | .25 -..... | .19 -..... |
| T. N. Bags, lb. | .19 -..... | .20 -..... | .10½-..... |
| Soapstone (f.o.b. Vt.), bags, ton. | 10.00 -12.00 | 10.00 -12.00 | 10.00 -12.00 |
| Talc, 200 mesh (f.o.b. Vt.), ton. | 8.00 - 8.50 | 8.00 - 8.50 | 8.00 - 8.50 |
| 300 mesh (f.o.b. Ga.), ton. | 7.50 -10.00 | 7.50 -10.00 | 7.50 -11.00 |
| 225 mesh (f.o.b. N. Y.), ton. | 13.75 -..... | 13.75 -..... | 13.75 -..... |

## INDUSTRIAL NOTES

HERCULES POWDER CO., Wilmington, Del., has named F. George Trescher as manager of its San Francisco office and R. W. McKee as manager of its office in Birmingham, Ala.

ROLLER-SMITH CO., Bethlehem, Pa., has appointed C. Swain Lumley as district engineer with headquarters at 53 W. Jackson Blvd., Chicago.

AJAX FLEXIBLE COUPLING CO., Westfield, N. Y., has appointed R. L. Johnstone as manager of its Shaker Division.

FOOTE BROS. GEAR & MACHINE CORP., Chicago, has advanced W. A. Barr to the position of executive vice-president and general manager.

AMERICAN CYANAMID & CHEMICAL CORP., New York, officially opened its new plant at Kalamazoo, Mich., on Dec. 18., with L. R. Verdon in charge. The first plant of the corporation in Kalamazoo was built 15 years ago

AMERICAN MACHINE AND METALS, INC., Moline, Ill., has appointed F. H. Fowler as assistant to the president and chief operating executive.

STEIN, HALL & CO., New York, is constructing a five-story and basement addition to its plant at Long Island City. The top floor will house the laboratory and rooms for pilot plant operations, instruments, and research.

COPPUS ENGINEERING CORP., Worcester, Mass., has appointed Rees V. Downs, Memphis, Tenn., Hughes Machinery Co., Kansas City, Mo., and L. D. McKay, Tulsa, Okla., as district representatives.

GAGER LIME CO., Sherwood, Tenn., has appointed Frank Nabers to the position of general manager.

WESTINGHOUSE ELECTRIC & MFG. CO., East Pittsburgh, Pa., has placed A. W. Pride in charge of its porcelain department at Emeryville, Calif.

WORTHINGTON PUMP AND MACHINERY CORP., Harrison, N. J., has named Harold W. Stoddart as manager of its turbine well pump division.

LINK-BELT CO., Chicago, has moved Ralph M. Hoffman from San Francisco to the main office where he will act as assistant to the president.

SHEFFLER-GROSS CO., Philadelphia, has added George F. Bertrand to its staff in the capacity of sales engineer.

IRON & STEEL PRODUCTS, INC., Chicago, has closed its branch in Tulsa, Okla.

MANNING, MAXWELL & MOORE, Bridgeport, Conn., has appointed Louis H. Brendel assistant to general sales manager C. H. Butterfield.

THE CONTINENTAL ROLL & STEEL FOUNDRY CO., East Chicago, Ind., has discontinued its stoker sales office in Chicago.